BBC

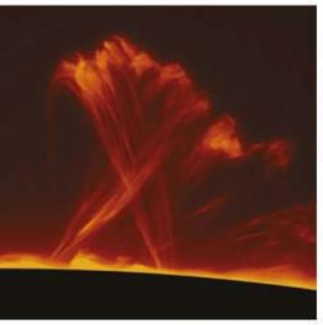
Sky at Night
MAGAZINE

COLLECTOR'S EDITION

Hotshots

VOLUME 1

181 STUNNING IMAGES OF THE COSMOS



PLUS... 7 ASTROPHOTO TUTORIALS FROM *THE SKY AT NIGHT'S* PETE LAWRENCE

NIGHTSCAPES ◆ AURORAE ◆ THE SUN ◆ THE MOON ◆ PLANETS & COMETS ◆ STARS & NEBULAE ◆ GALAXIES

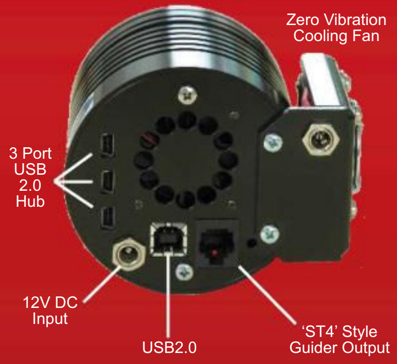
The TRIUS range of Cooled Deep-Sky Cameras

Starlight Xpress have always been renowned for small, compact, innovative and excellent build quality. The new TRIUS range of cameras has just taken this to a whole new level.

In addition to the already super low-noise performance of the previous generations of SXV, SXVF, & SXVR cameras, the new TRIUS is even better, whilst still offering fast download times of approximately 2 million pixels per second.

Remarkably, we have managed to incorporate a complete powered USB hub into the main camera, which offers 3 USB 2.0 ports at the rear of the camera. Each port is capable of delivering up to 200mA, and is able to drive an UltraStar, Lodestar, SuperStar or CoStar for guiding and still has another two USB ports for one of our USB filter wheels and an Active Optics unit etc. This integration greatly reduces the number of cable trails back to the computer stopping cables tangling around the mount during your imaging session.

New Peltier cooler combinations have been designed into the TRIUS cameras. Along with the Argon-Filled CCD chamber, this allows a greater differential cooling to be achieved.



Rear Camera Panel

The TRIUS Camera provides multiple inputs and outputs. The main control connections to the camera are the USB2.0 socket that controls the camera from the computer and the +12v DC jack socket which provides power (approximately 1.25Amps at 12v DC). In addition, there is an RJ11 Guider Port output that is opto-isolated and will drive any standard active-low guider input via the RJ11 'telephone' lead provided. The remaining sockets are three Mini-5pin USB2.0 sockets that can be used to power up to three different USB devices, such as a Lodestar Autoguider, an SX USB Filter Wheel and a focuser. Each USB port is capable of providing 5v DC at a maximum of 200mA.

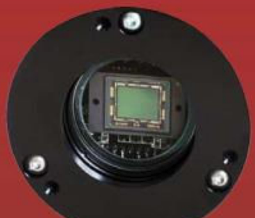
Fused Silica Window

Unlike less expensive cameras, we fit a specially manufactured fused silica window, with a 7 layer anti-reflective coating, to all of our TRIUS Cameras. This offers exceptional strength and heat transfer characteristics to ensure there is less chance of dewing of the front window during humid weather.

Efficient Cooling System

The cooling system is designed for the most efficient cooling possible in a small compact package. The TRIUS cameras are fitted with a new peltier cooler configuration to give approximately -40C delta T. A built in fan at the rear of the camera draws air in through small holes in the front of the barrel (which increases the surface area to aid the convection), through the heatsink where all the heat is generated, and expels it out of the rear of the camera. An additional fan is fitted to the side, just to help keep the external body at the ambient temperature during warmer weather.

Unique Tilted Camera Front



This unique approach to camera design allows the front plate of the camera to be orthogonally aligned to ensure that the CCD and the optics are parallel to each other. This enables the user to adjust for any collimation issues throughout the whole optical train, to ensure pinpoint stars across the entire field.

Argon Filled CCD Chamber

Argon filled CCD chambers are normally only associated with really high-end cameras; the new TRIUS cameras have dry argon injected into the CCD chamber to ensure there is no moisture to condense on the CCD during the cooling process. The low thermal conductivity of argon also helps with the cooling process, allowing a lower temperature to be achieved.

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WELCOME

The Universe is a beautiful place. Whether it's aurorae or galaxies, planets or nebulae, the swirling shapes and striking colours of the night sky are begging to be captured in photographs. So it should come as no surprise that amateur astronomers across the world are producing wonderful images of celestial objects.

Every month, *BBC Sky at Night Magazine* features a selection of your images in its Hotshots section, from where the photographs on the following pages are taken. It's always an exciting part of the magazine to put together, as every month amateur astronomers surprise us with the colour and detail they are able to squeeze out of their cameras and telescopes.

And while it's true there can be a bit of specialist equipment involved in astrophotography – some of the images here were taken with high frame rate planetary cameras, tracking mounts and filter wheels, or even dedicated solar telescopes – the majority were shot using an unmodified DSLR camera, some of them more than 10 years old. There's even one from a mobile phone.

> “Every month amateur astronomers surprise us with the colour and detail they squeeze out of their cameras and telescopes”

We've also included tutorials from *Sky at Night* presenter Pete Lawrence, showing you how to set your camera to capture some of the most popular targets in the night sky.

So if the images you see over the next 110 pages inspire you, there's nothing to stop you having a go yourself. All you need are a camera, clear dark skies, and a little knowledge. Make sure you send your captures in to the magazine – you might see them in print. Email them to hotshots@skyatnightmagazine.com or through our website.

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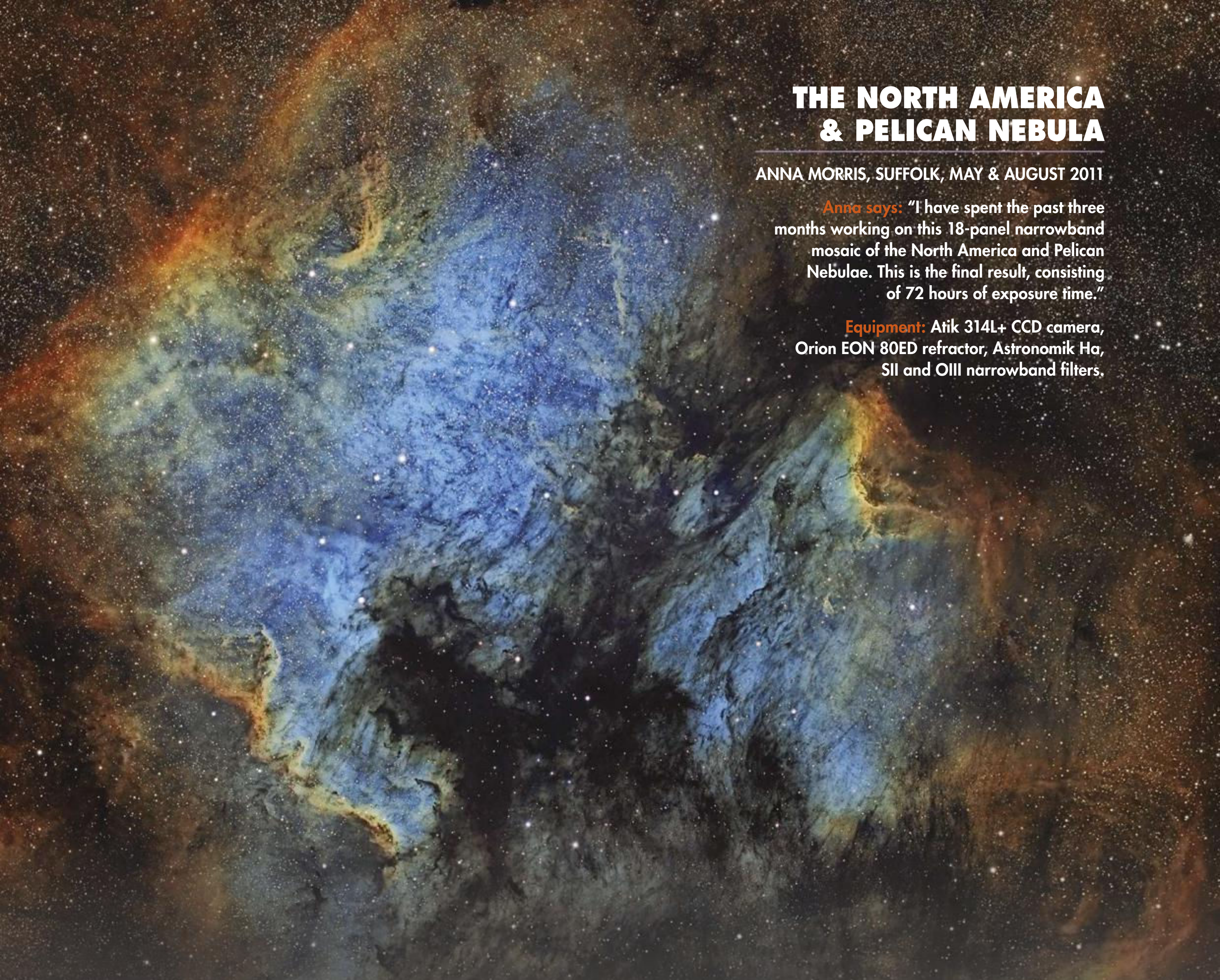


THE NORTH AMERICA & PELICAN NEBULA

ANNA MORRIS, SUFFOLK, MAY & AUGUST 2011

Anna says: "I have spent the past three months working on this 18-panel narrowband mosaic of the North America and Pelican Nebulae. This is the final result, consisting of 72 hours of exposure time."

Equipment: Atik 314L+ CCD camera, Orion EON 80ED refractor, Astronomik Hα, SII and OIII narrowband filters.

Contents

6 GALLERY NIGHTSCAPES

20 **Astrophotography Tutorial:** Noctilucent clouds

22 **SUBSCRIBE** to *BBC Sky at Night Magazine*

24 GALLERY AURORAE

36 **Astrophotography Tutorial:** Capturing the aurora

38 GALLERY THE SUN

50 **Astrophotography Tutorial:** The Sun's rotation

52 GALLERY THE MOON

66 **Astrophotography Tutorial:** Thin crescent Moon mosaics

68 GALLERY PLANETS & COMETS

80 **Astrophotography Tutorial:** Imaging Mars at opposition

82 GALLERY STARS & NEBULAE

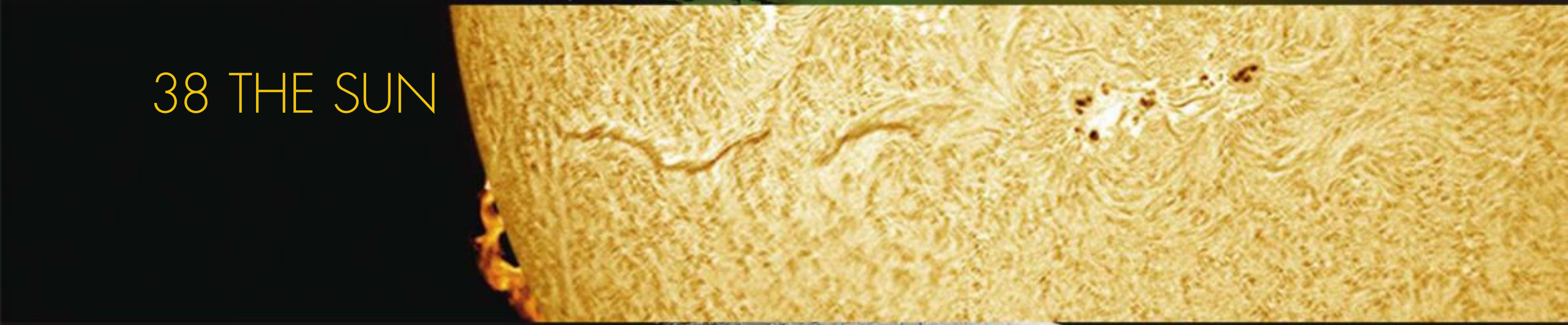
98 **Astrophotography Tutorial:** The Orion Nebula

100 GALLERY GALAXIES

112 **Astrophotography Tutorial:** Shoot M31 with a DSLR

6 NIGHTSCAPES

24 AURORAE



38 THE SUN

52 THE MOON

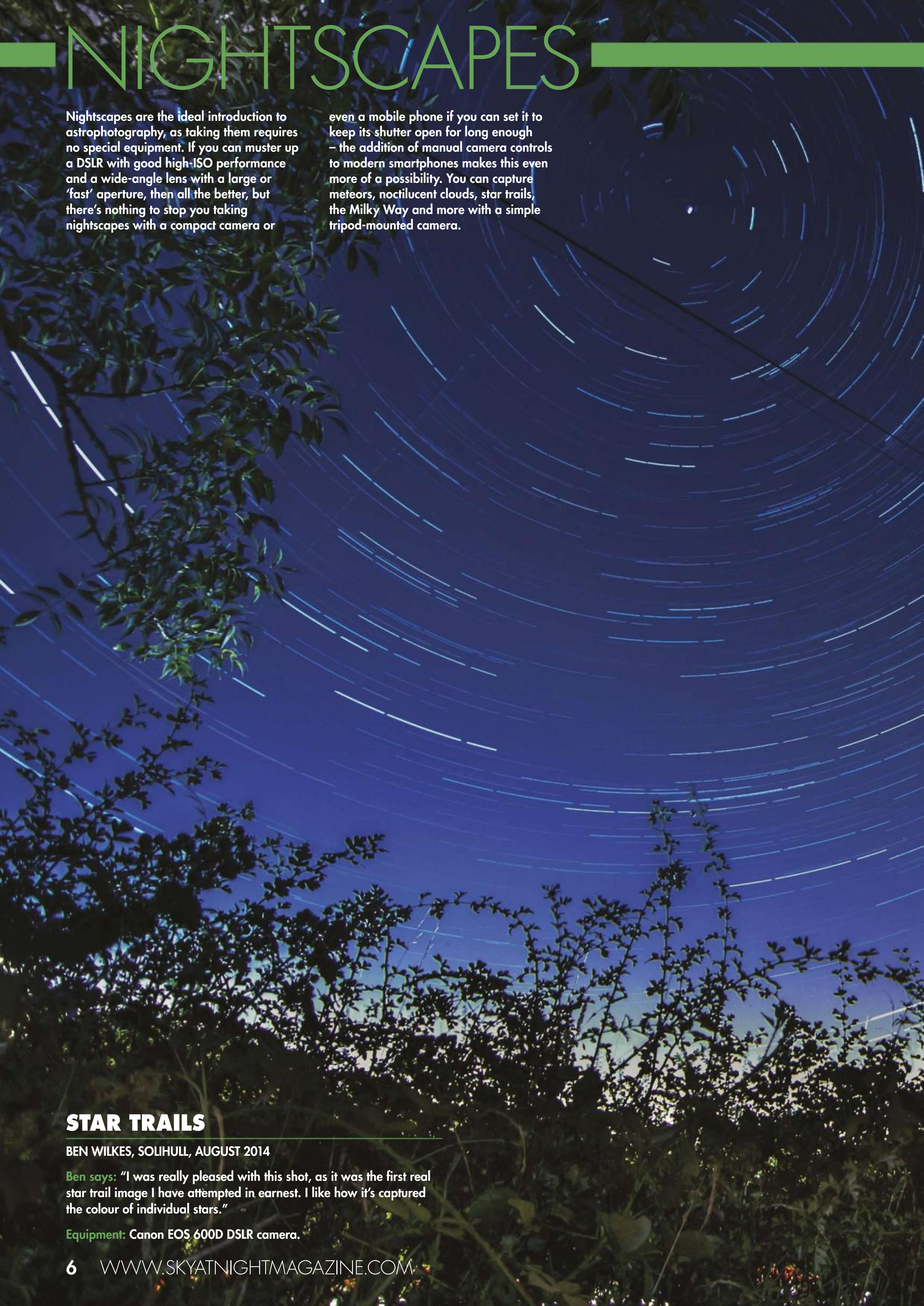
68 PLANETS AND COMETS

82 STARS AND NEBULAE

100 GALAXIES

NIGHTSCAPES

Nightscapes are the ideal introduction to astrophotography, as taking them requires no special equipment. If you can muster up a DSLR with good high-ISO performance and a wide-angle lens with a large or 'fast' aperture, then all the better, but there's nothing to stop you taking nightscapes with a compact camera or even a mobile phone if you can set it to keep its shutter open for long enough – the addition of manual camera controls to modern smartphones makes this even more of a possibility. You can capture meteors, noctilucent clouds, star trails, the Milky Way and more with a simple tripod-mounted camera.

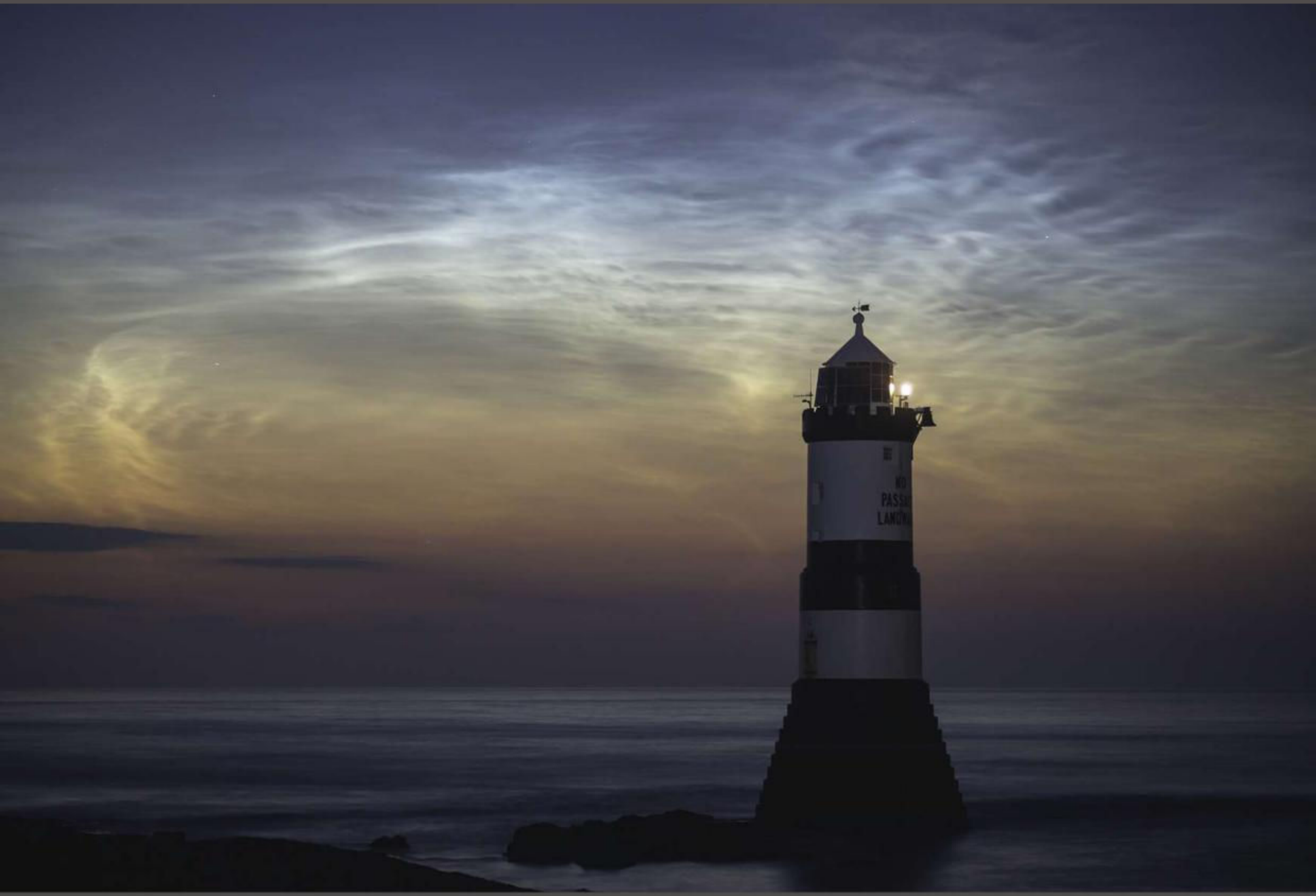


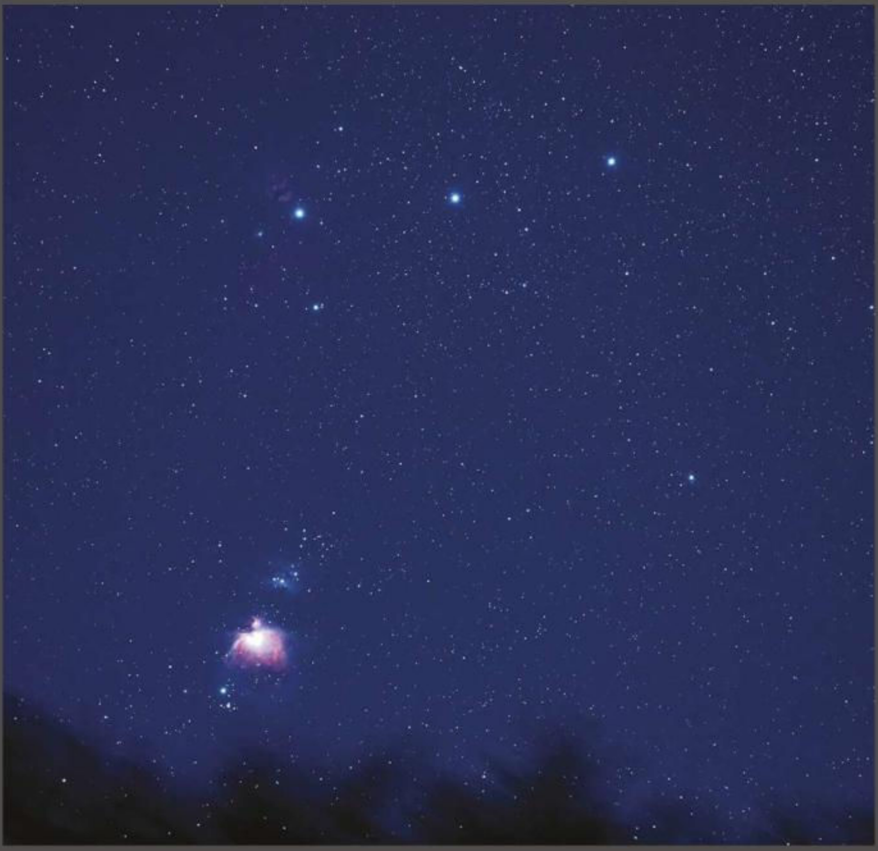
STAR TRAILS

BEN WILKES, SOLIHULL, AUGUST 2014

Ben says: "I was really pleased with this shot, as it was the first real star trail image I have attempted in earnest. I like how it's captured the colour of individual stars."

Equipment: Canon EOS 600D DSLR camera.





▲ NOCTILUCENT CLOUDS

KRIS WILLIAMS, ANGLESEY, 30 MAY 2013

Kris says: "I was reading *BBC Sky at Night Magazine* on my iPad when I saw an article by Pete Lawrence on noctilucent clouds. It reminded me of this image I took from Penmon Point on Anglesey looking out over the Irish Sea."

Equipment: Sony A99 DSLR camera, Minolta 100mm f/2.8 macro lens.

◀ ORION'S BELT

JAMES COARD, LISBURN,
23 NOVEMBER 2014

James says: "I had planned to get up very early to image Orion but overslept, only managing to photograph the constellation as it started to set behind some trees. I was still pleased with the result, especially as there is a hint of nebulosity around the belt star Alnitak."

Equipment: Canon EOS 5D MkIII DSLR camera, 70-200mm f/4 lens lens at 159mm and f/4, iOptron SkyTracker.

▼ THE MILKY WAY

BRINTON DARNELL, NORTH YORKSHIRE, 13 NOVEMBER 2015

Brinton says: "This is one of my favourite Milky Way captures as I included quite a bit of foreground. I used four images of the wonderful view to the south from my house and captured light pollution from the Teesside glow to my advantage as I like the effect!"

Equipment: Nikon D3100 DSLR camera, Samyang 14mm lens.

THE LYRID METEOR SHOWER ▶

JOHN SHORT, TYNE AND WEAR, 22 APRIL 2015

John says: "Capturing meteors cannot be left to manual exposure. I was able to automate the process using Magic Lantern software."

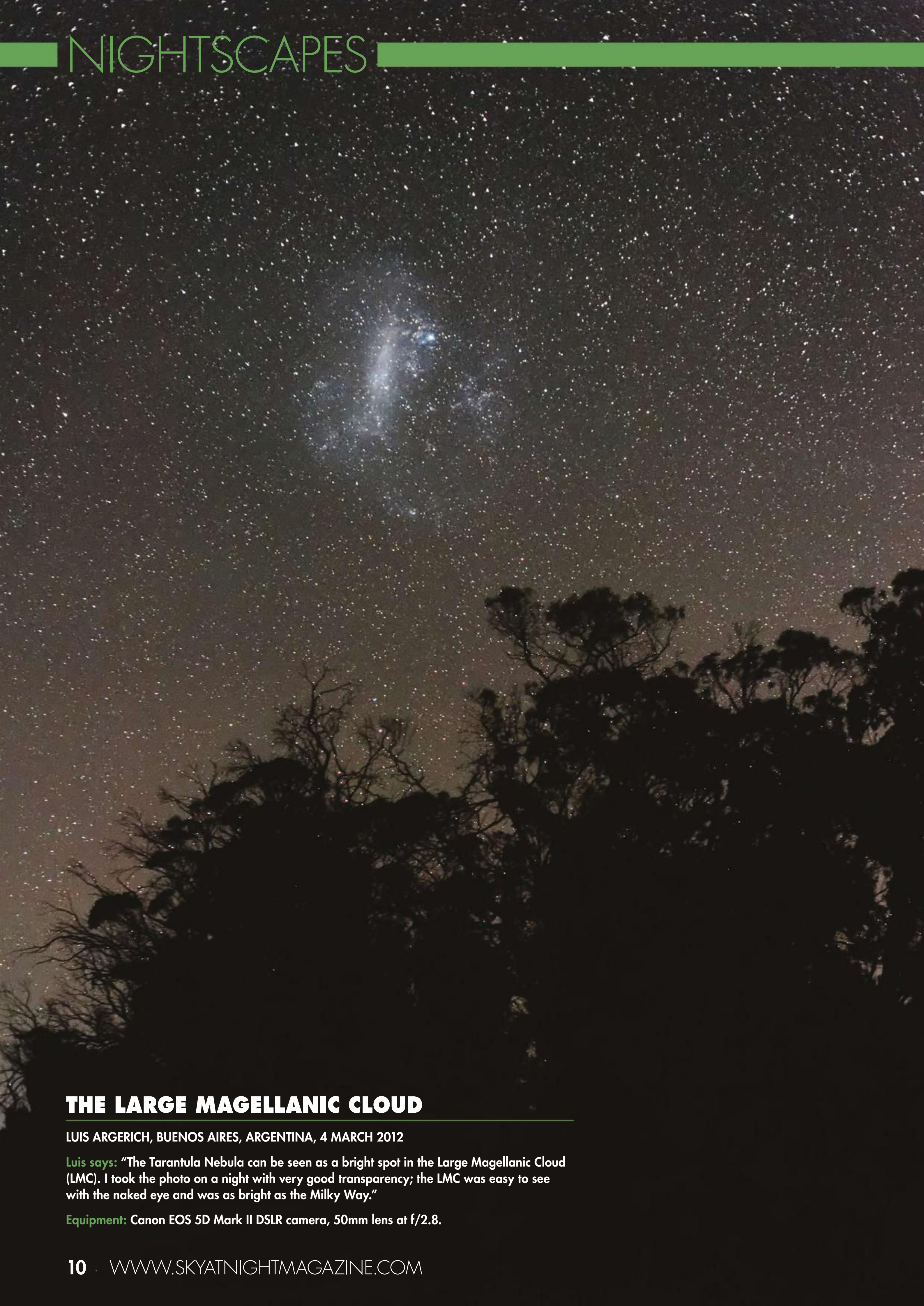
Equipment: Canon EOS 6D DSLR camera, Canon 8-15mm f/4 fisheye lens, Magic Lantern software.

▲ STAR TRAILS ABOVE MOUNT TEIDE, SPAIN

MARC PINTER-KRAINER, TEIDE NATIONAL PARK, 11 SEPTEMBER 2008

Mark says: "Taking this image was actually a pretty scary experience. I was in total solitude and silence up at 7,000ft. Sometimes I would stop to sense what a particular noise was, only to find it was me breathing!"

Equipment: Canon EOS 5D DSLR, 24-105mm f/4 lens at 24mm and f/4.

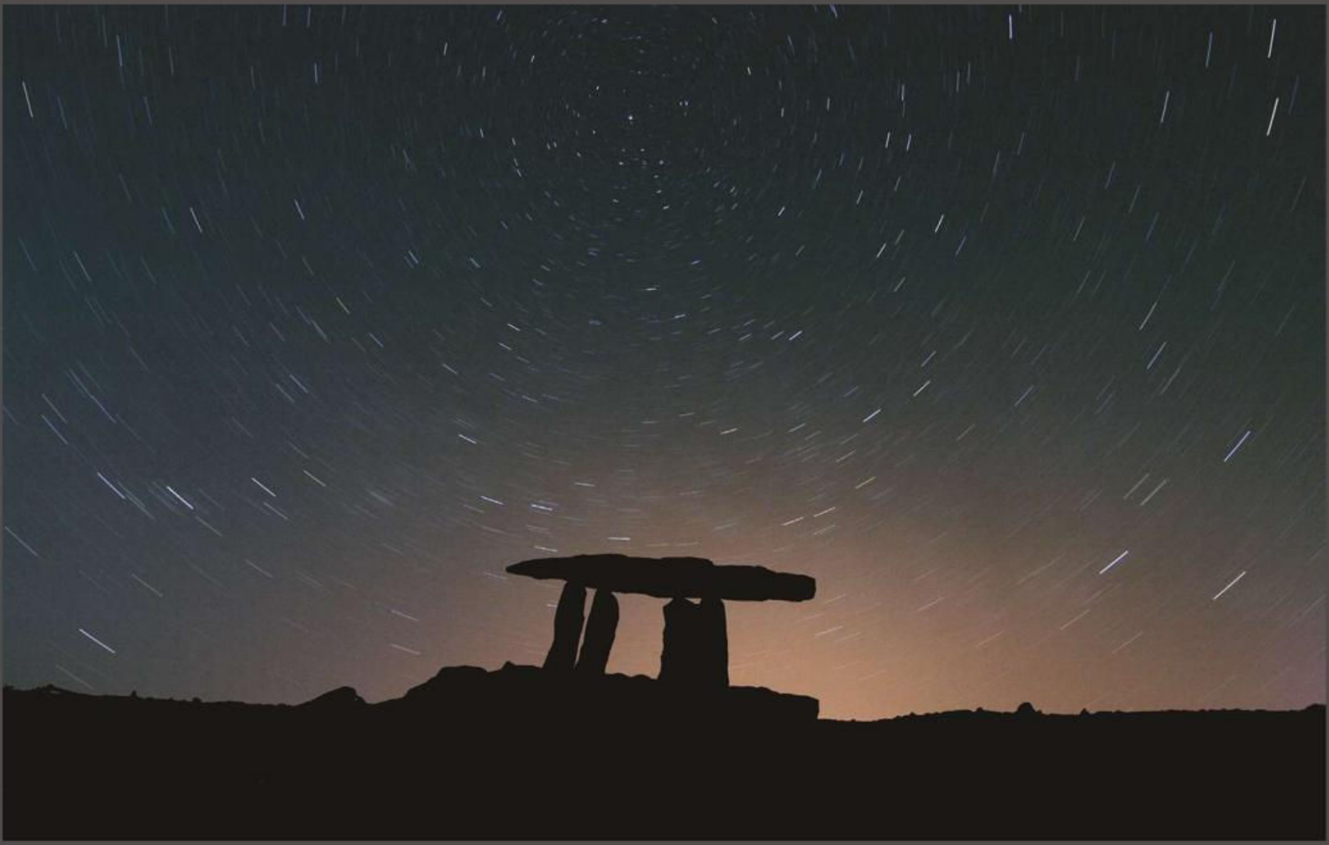


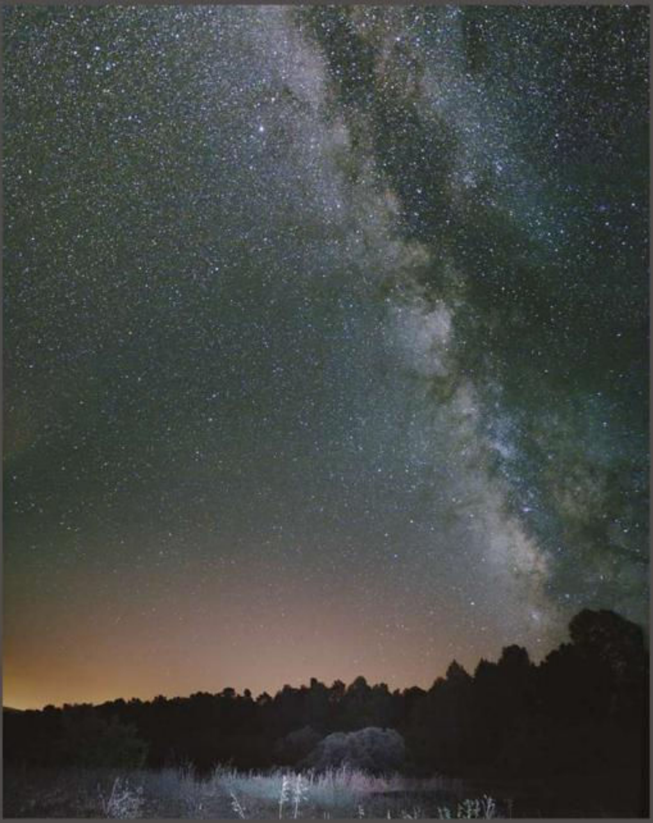
THE LARGE MAGELLANIC CLOUD

LUIS ARGERICH, BUENOS AIRES, ARGENTINA, 4 MARCH 2012

Luis says: "The Tarantula Nebula can be seen as a bright spot in the Large Magellanic Cloud (LMC). I took the photo on a night with very good transparency; the LMC was easy to see with the naked eye and was as bright as the Milky Way."

Equipment: Canon EOS 5D Mark II DSLR camera, 50mm lens at f/2.8.



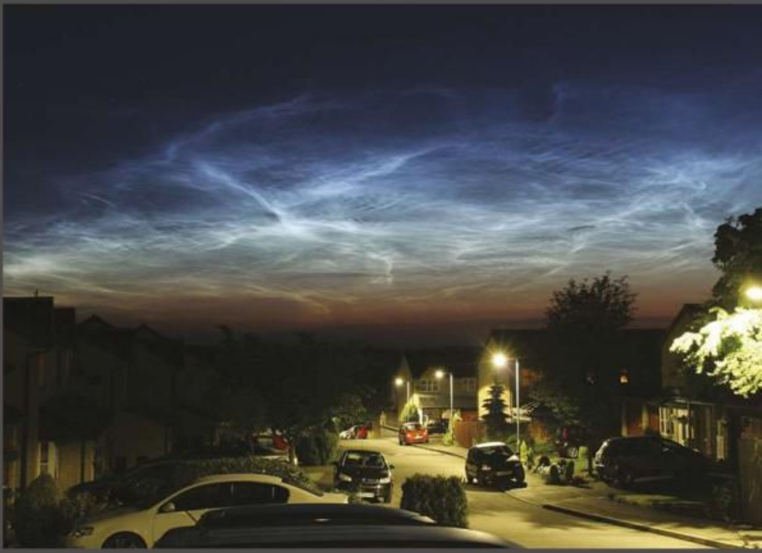


▲ STAR TRAILS OVER POULNABRONE DOLMEN

FRANK RYAN JR, THE BURREN, CO. CLARE, IRELAND, APRIL 2008

Frank says: "The Poulnabrone Dolmen (Poll na mBrón means 'hole of sorrows' in Irish) is a Neolithic tomb that dates back to about 2500BC."

Equipment: Canon EOS 350D DSLR camera, Tokina 12-24mm lens.



▲ THE MILKY WAY

DYLAN WALTON, CHARMOUTH, DORSET, 29 JULY 2015

Dylan says: "The sky was so dark the night I took this you could see the Milky Way with the naked eye. I couldn't resist capturing its beauty to share with my friends and family at home in Birmingham."

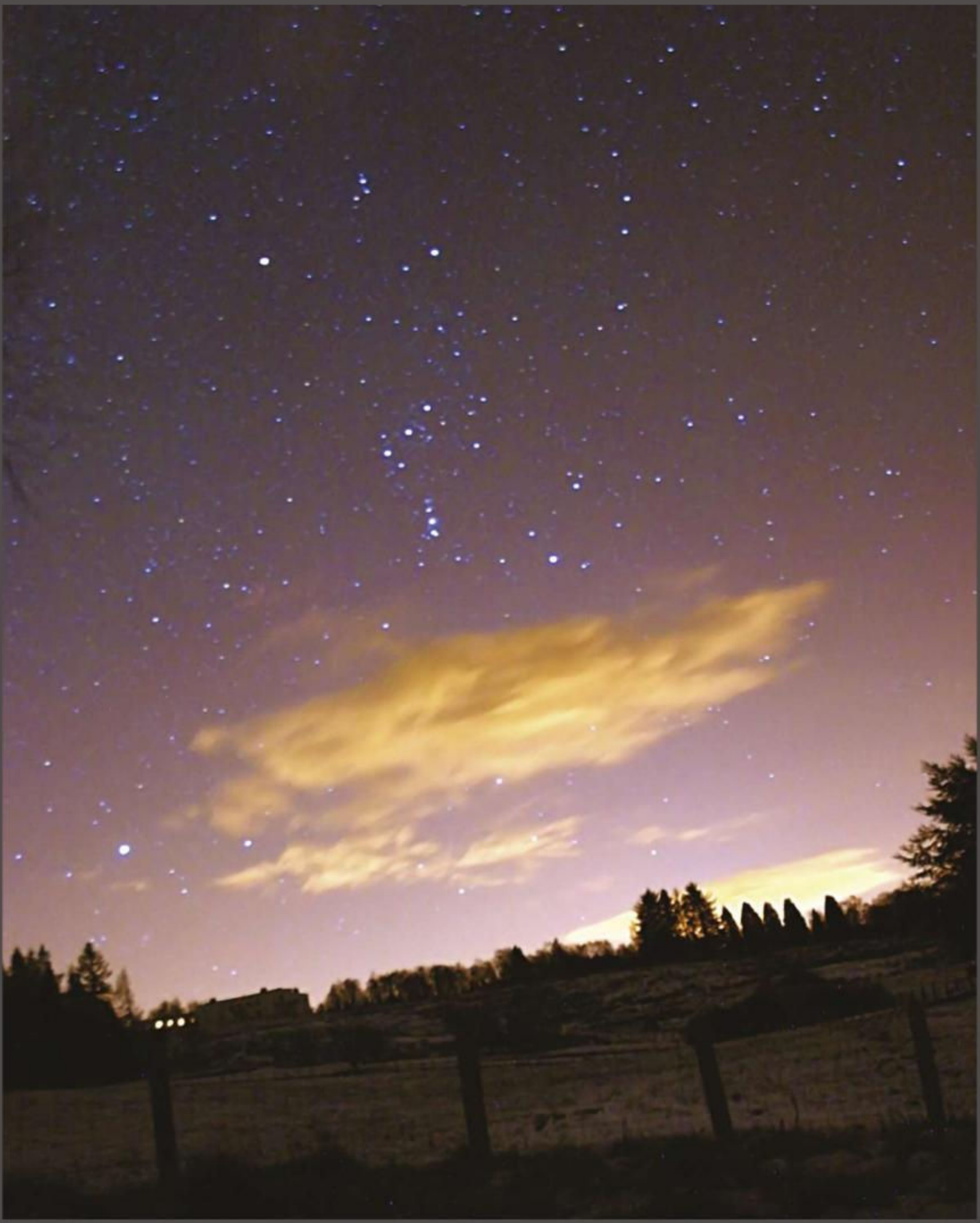
Equipment: Canon EOS 350D DSLR camera piggybacked on a Sky-Watcher Explorer-150P reflector, Sky-Watcher EQ2-3 mount.

▲ NOCTILUCENT CLOUDS

DAVE THOMPSON, COUNTY DURHAM, 3 JULY 2011

Dave says: "I like the contrast between the busy cloud detail and the deserted street. It reminds us that, while we sleep, nature is always active."

Equipment: Canon EOS 20D DSLR camera, Sigma 18-200mm lens.



◀ ORION

NEIL ENGLISH, STIRLINGSHIRE, SCOTLAND, 1 JANUARY 2006

Neil says: "This 30-second shot of Orion was taken looking due south over Gribloch House near my home in rural Stirlingshire."

Equipment: Canon EOS 300D DSLR camera.

▼ SUPER MOON

MIGUEL CLARO, PORTUGAL, 23 JUNE 2013

Miguel says: "This huge full Moon rises above the church of Nossa Senhora do Castelo in the picture. It stands on the spot where King Sancho I built a Romanesque chapel in the early 13th century."

Equipment: Canon EOS 50D DSLR camera, Astro Professional ED-80 apo refractor, Sky-Watcher EQ2-3 mount.

▲ RISING GALAXY

ANVAR GHADERI, KURDISTAN, IRAN, 26 APRIL 2015

Anvar says: "This photo was taken on a starry night in a village between two cities that give off a lot of light pollution. They can be seen in the distance, with Baneh on the left and Armerdeh on the right."

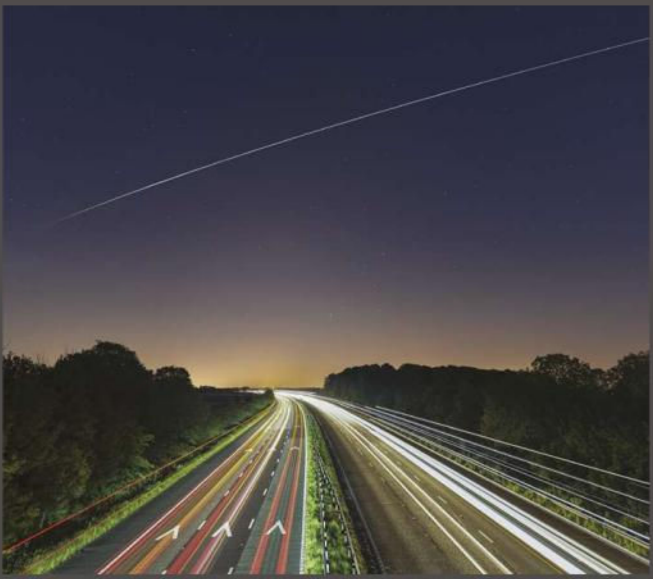
Equipment: Canon EOS 5D DSLR camera, Samyang 14mm f/2.8 lens.

◀ STAR TRAILS

MARIUSZ SZYMASZEK, CAMBRIDGESHIRE, 4 MARCH 2015

Mariusz says: "This is one of a series of photos I took near the decommissioned One-Mile Telescope at the Mullard Radio Astronomy Observatory."

Equipment: Pentax K-01 compact system camera, Tamron 17-50 f/2.8 lens at 17mm and f/2.8, Velbon VEB-3 mount.



▲ ISS PASS OVER THE M6

STEPHEN CHEATLEY, LANCASHIRE, 25 JANUARY 2016

Stephen says: "I planned this shot because I knew the ISS was due to pass over twice that night, opting for the second because it would happen under a darker sky. My aim was to compare light trails of the motorway traffic with that of the ISS."

Equipment: Nikon D600 DSLR camera, 14-24mm f/2.8 lens.

▼ SUPER MOON

PREMJITH NARAYANAN, BAHRAIN, 23 JUNE 2013

Premjith says: "The most important part of this photo is the inclusion of the great Tree of Life, which has survived the harsh conditions of the desert for over 400 years without water."

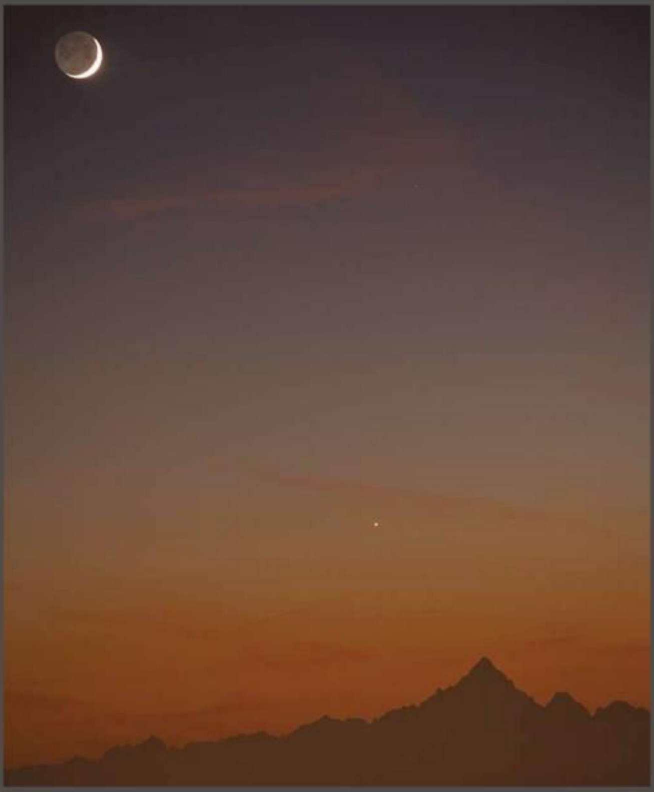
Equipment: Canon EOS 5D Mk III DSLR camera, Canon 24-70mm f/2.8 lens at 70mm and f/8.

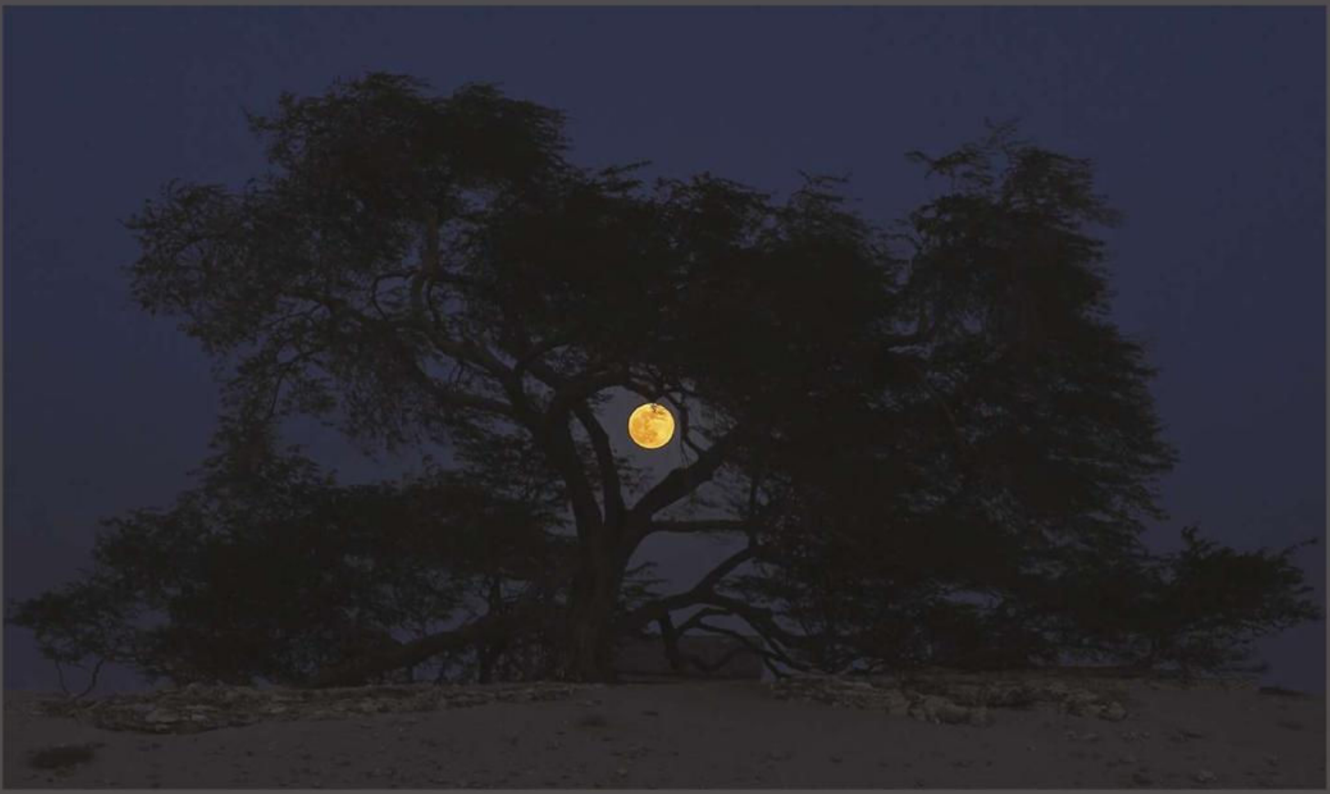
▼ THE MOON AND VENUS OVER MONVISO

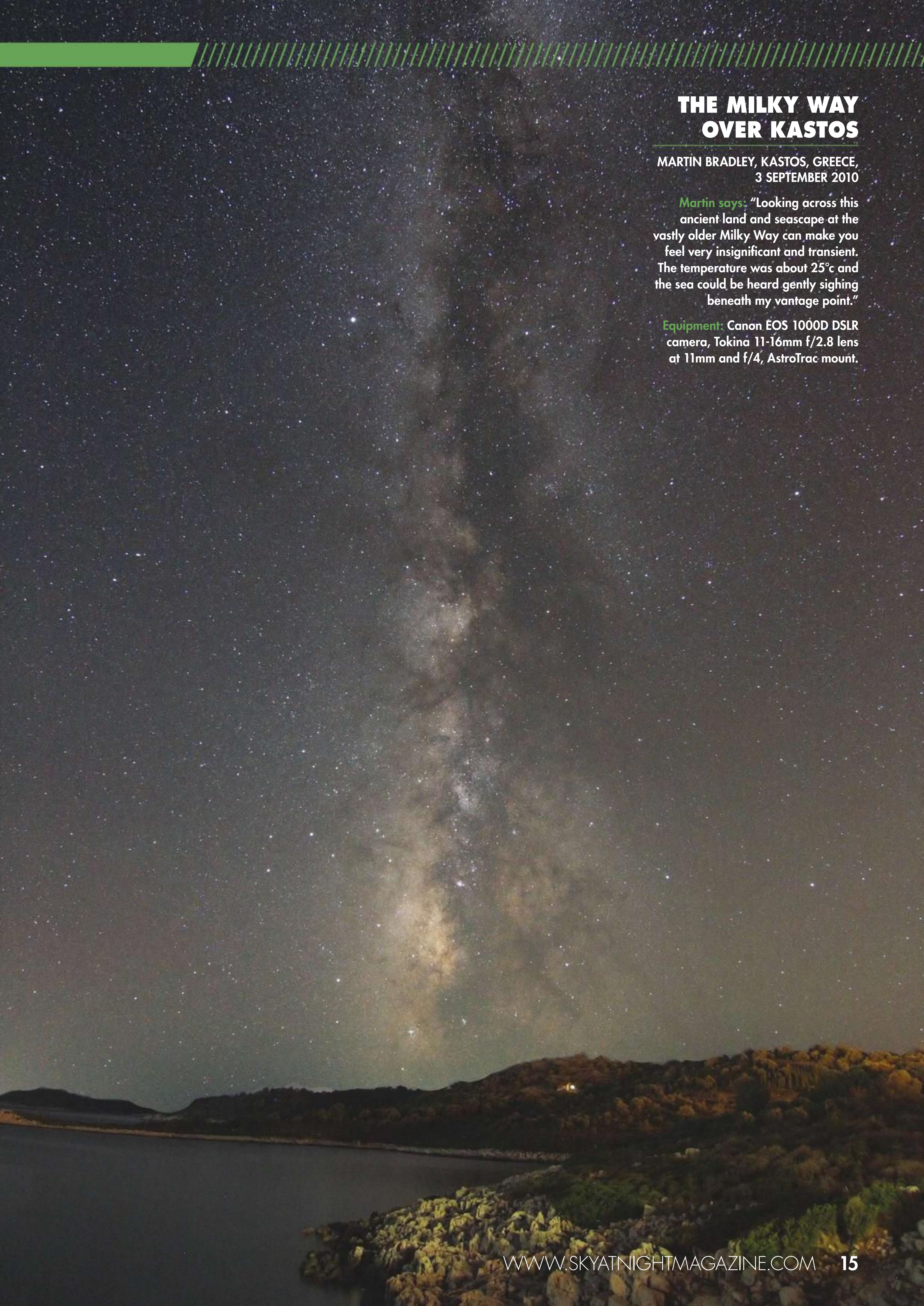
STEFANO DE ROSA, TURIN, ITALY, 27 NOVEMBER 2011

Stefano says: "The crescent Moon (with a beautiful earthshine) and brilliant Venus put on a great show over the Monviso, the highest peak in the Cottian Alps. Its pyramid shape is visible from large areas of northwestern Italy."

Equipment: Canon EOS 5D Mark II DSLR camera, Sigma 150-500mm lens at 174mm and f/5.6.





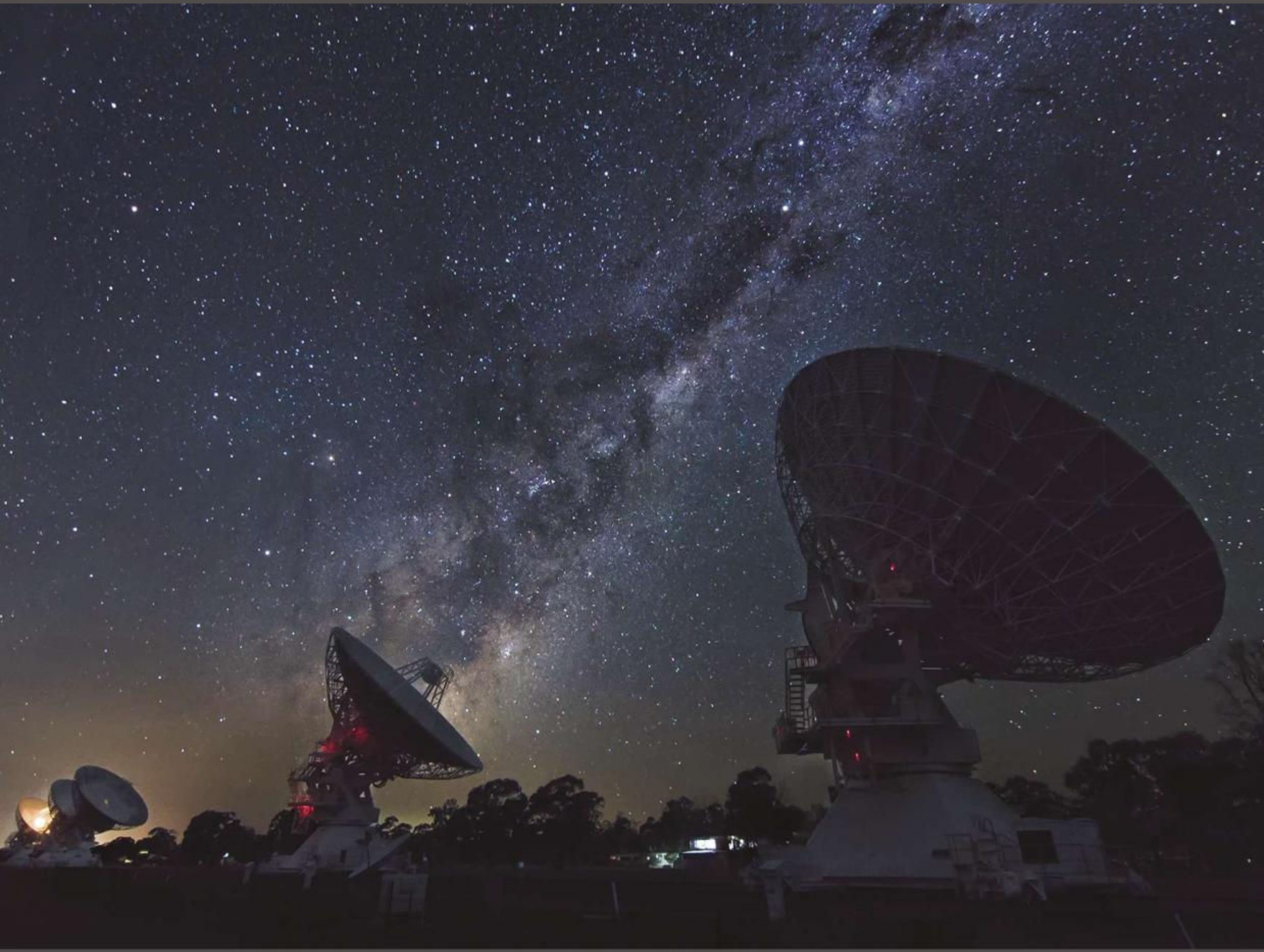


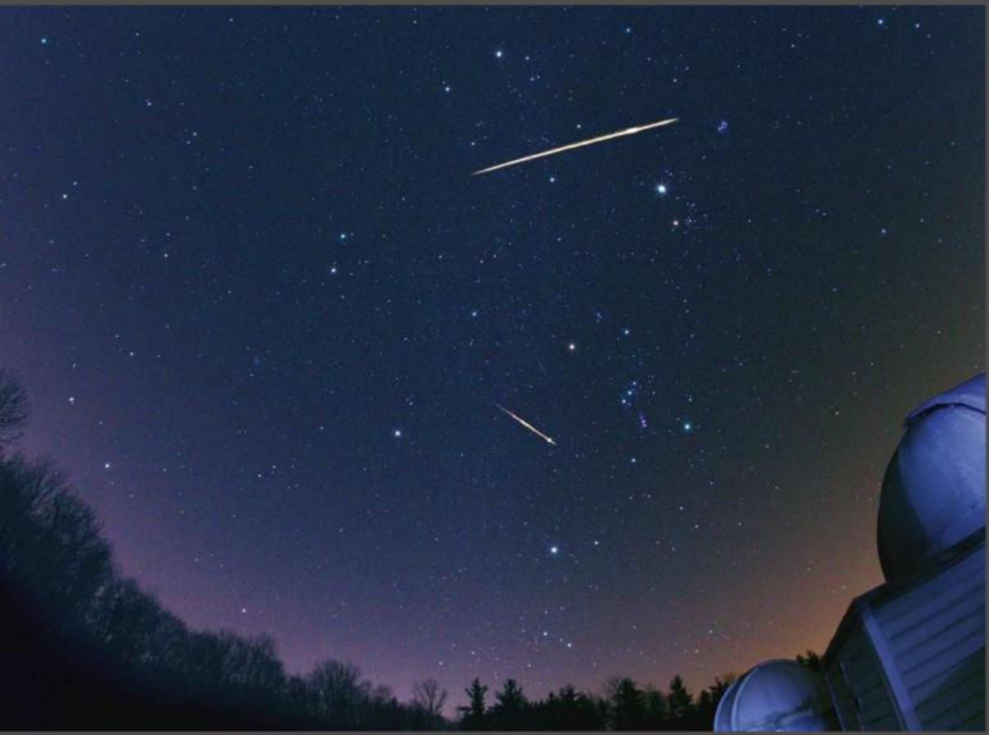
THE MILKY WAY OVER KASTOS

MARTIN BRADLEY, KASTOS, GREECE, 3 SEPTEMBER 2010

Martin says: "Looking across this ancient land and seascape at the vastly older Milky Way can make you feel very insignificant and transient. The temperature was about 25°c and the sea could be heard gently sighing beneath my vantage point."

Equipment: Canon EOS 1000D DSLR camera, Tokina 11-16mm f/2.8 lens at 11mm and f/4, AstroTrac mount.





▲ GALATIC BEAM

IVAN SLADE, AUSTRALIAN TELESCOPE COMPACT ARRAY, 13 FEBRUARY 2016

Ivan says: "I had seen these telescopes online and knew the night skies must be very dark. Just as the telescopes reoriented I could see a chance of getting the shot I wanted; the antenna aligning with the Milky Way as if sending a beam into the cosmos."

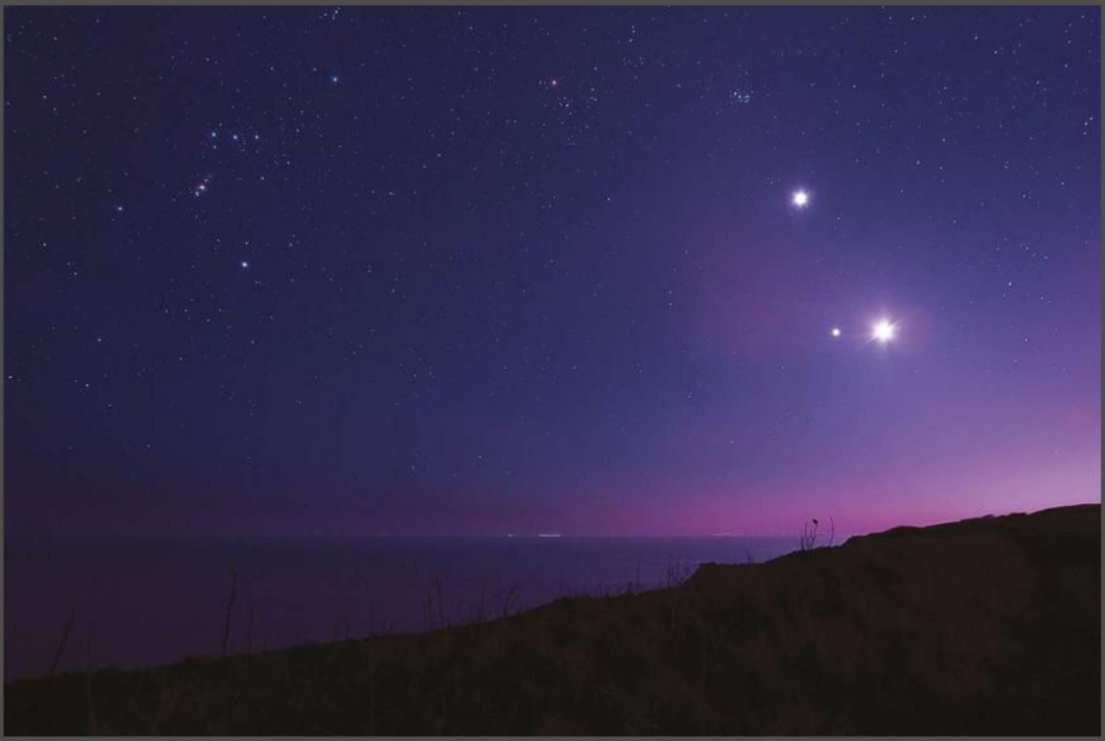
Equipment: Sony α7S MK II camera, Tamron 15-30mm f/2.8 lens, AstroTrac mount.

◀ GEMINID METEORS

JOHN CHUMACK, OHIO, USA, 12 DECEMBER 2012

John says: "I was seeing one or two meteors every minute or so – definitely one of the best Geminid showers I've seen in over 20 years! My meteor video cameras at home also recorded over 150 bright Geminids."

Equipment: Modified Canon EOS 450D DSLR camera, 8mm fisheye lens.

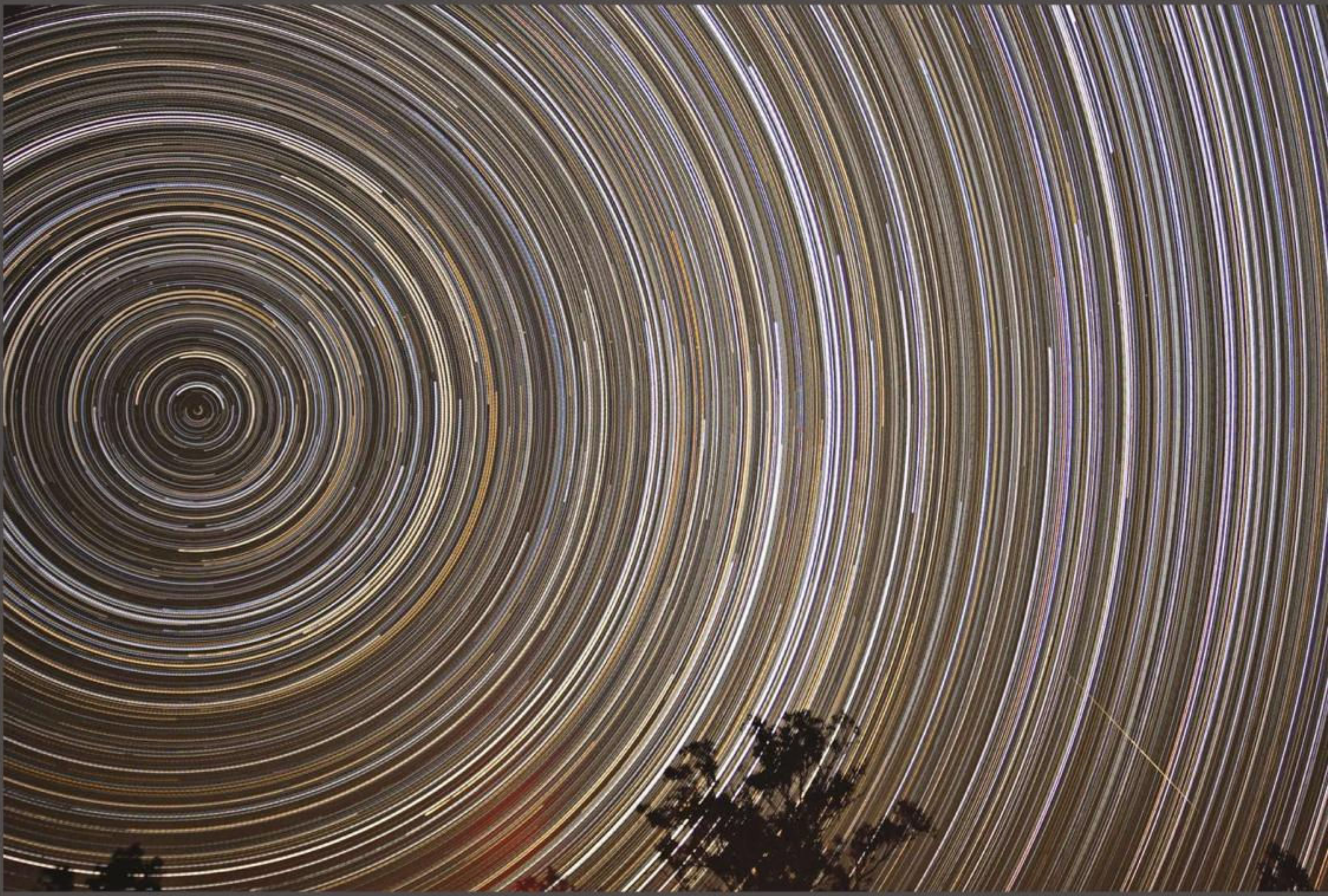


◀ VENUS, JUPITER AND THE MOON

GRAHAM GREEN, BRIGHSTONE, ISLE OF WIGHT, 25 MARCH 2012

Graham says: "This meeting of Venus and Jupiter with the crescent Moon was too good to miss. The Pleiades with Orion and M42 makes a pleasing composition."

Equipment: Canon EOS 600D DSLR camera, 14mm f/2.8 lens at f/5.6, Astronomik filter, AstroTrac mount.

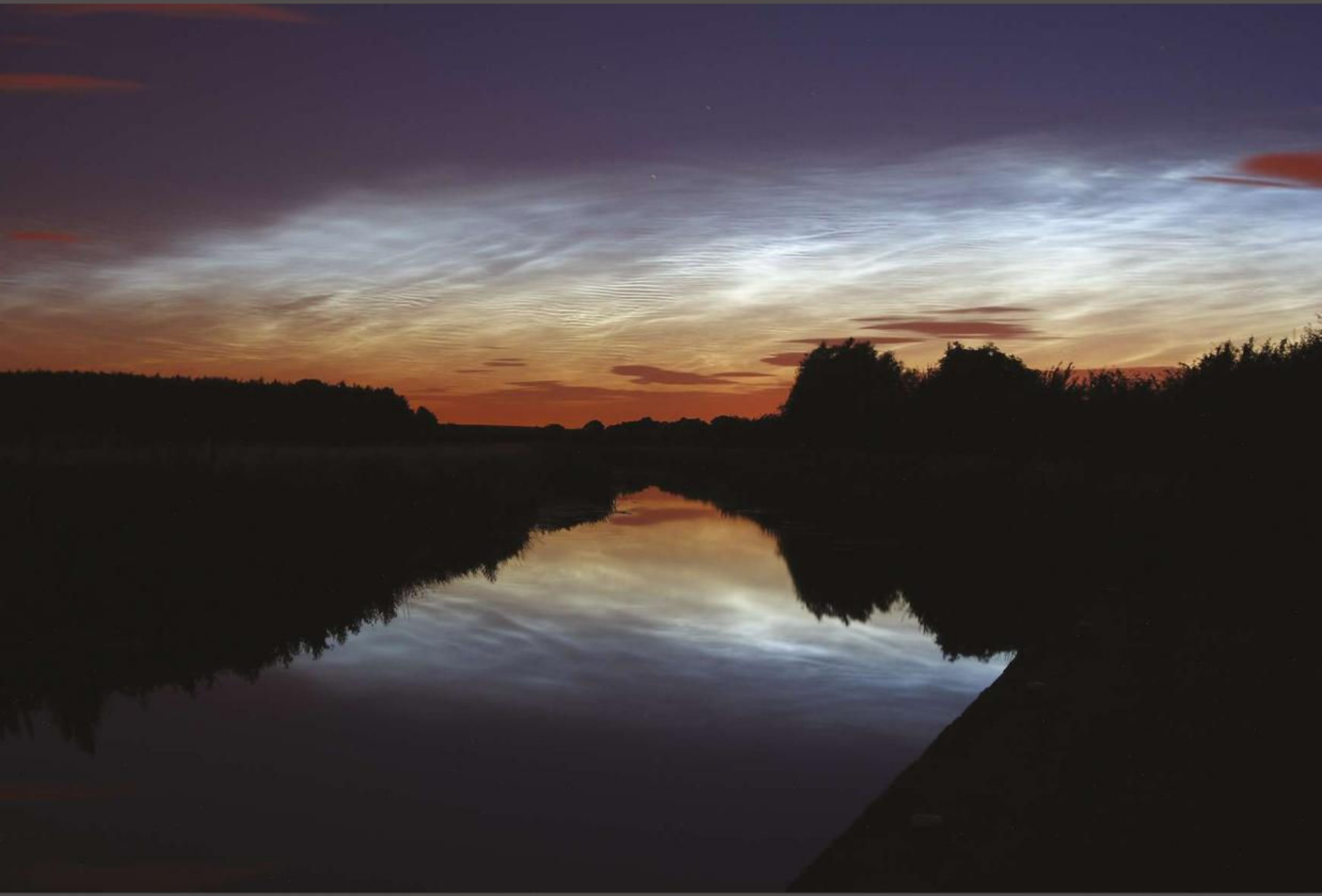


▲ SOUTHERN SKY TRAILS

DAVID HOUGH, QUEENSLAND, AUSTRALIA, AUGUST 2009

David says: "This image is made up of three-minute exposures starting from 6.55pm in the evening to 5.05am the next morning (with a three second gap between exposures to save the image onto the camera's memory card)."

Equipment: Pentax K10D DSLR camera, Sigma 20-40mm f/2.8 lens.



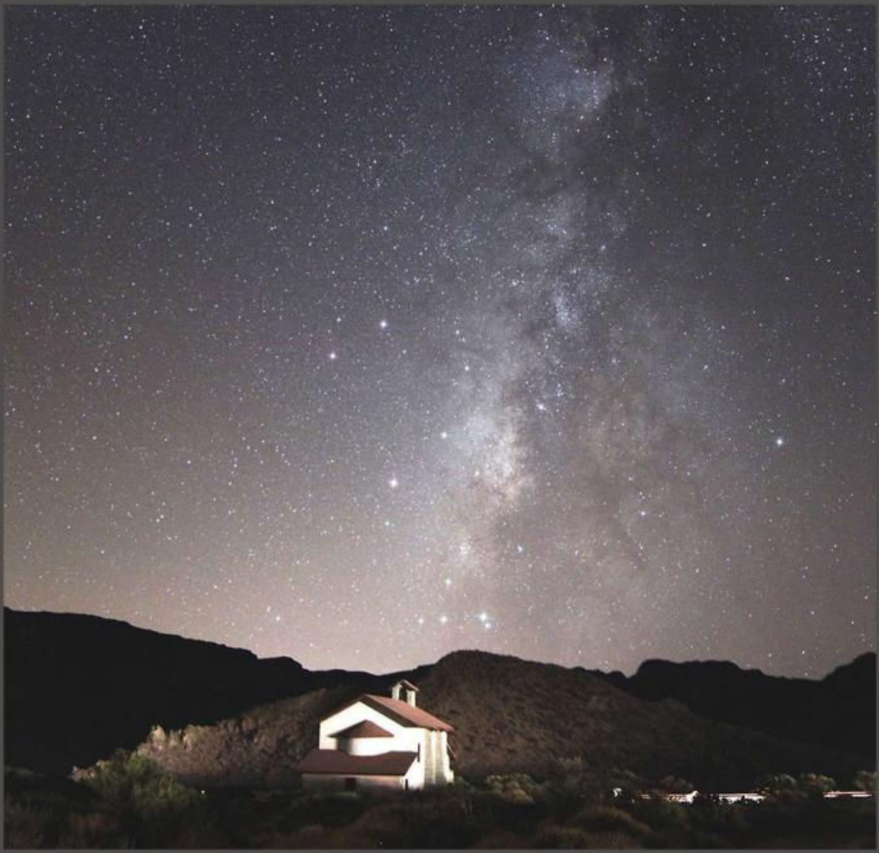
▲ NOCTILUCENT CLOUDS

MIKE CLARKE, NOTTINGHAMSHIRE, UK, 12 JULY 2009

Mike says: "I like this image because of the memories that it brings back of a great NLC display on a warm summer night from a superb observing site. While I was taking the image, and just metres from me, there were two otters playing and feeding in the water. It was simply brilliant."

Equipment: Canon 350D DSLR camera and Sigma 18-35mm lens.

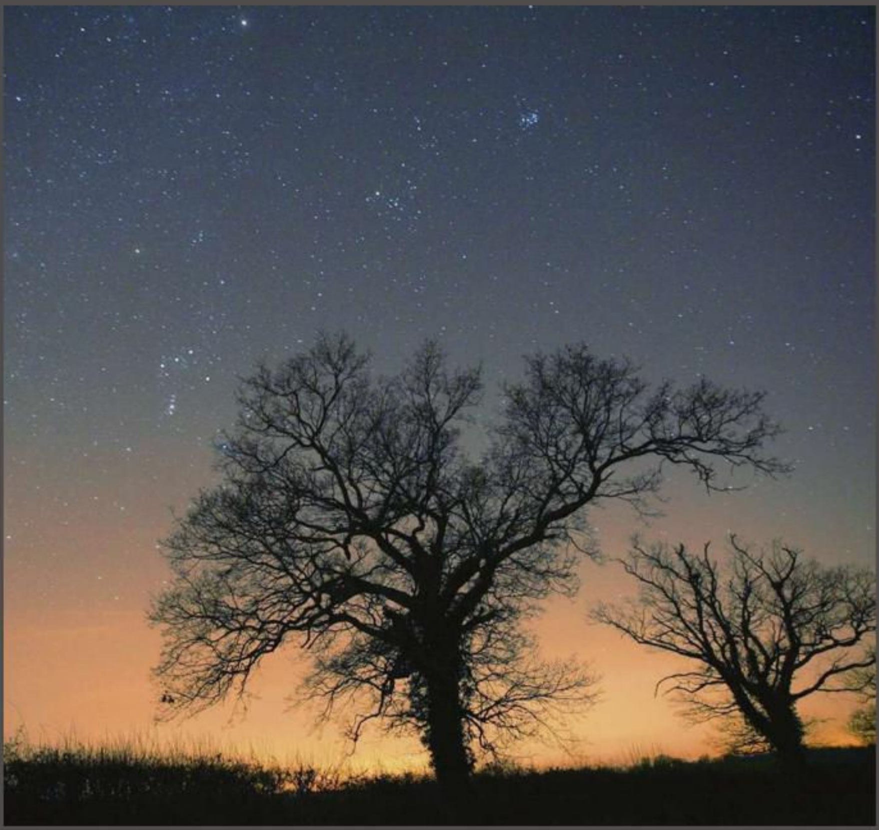
MILKY WAY OVER TENERIFE ▶



WILLIAM HUGHES, TENERIFE, 11 SEPTEMBER 2012

William says: "I captured this at an altitude of 2,150m in Parador Canadas del Teide on Tenerife. A passing car illuminated the chapel and mountain in the foreground with its headlights, giving a very pleasing effect."

Equipment: Canon EOS 600D DSLR camera, 14mm lens, Vixen Polarie Star Tracker.



◀ ORION, TAURUS AND THE PLEIADES

PETER SIMS, SUFFOLK, 27 JANUARY 2008

Peter says: "I was in an ink-black dark site in the middle of Suffolk and yet the light pollution from towns 15km away was still visible in the image."

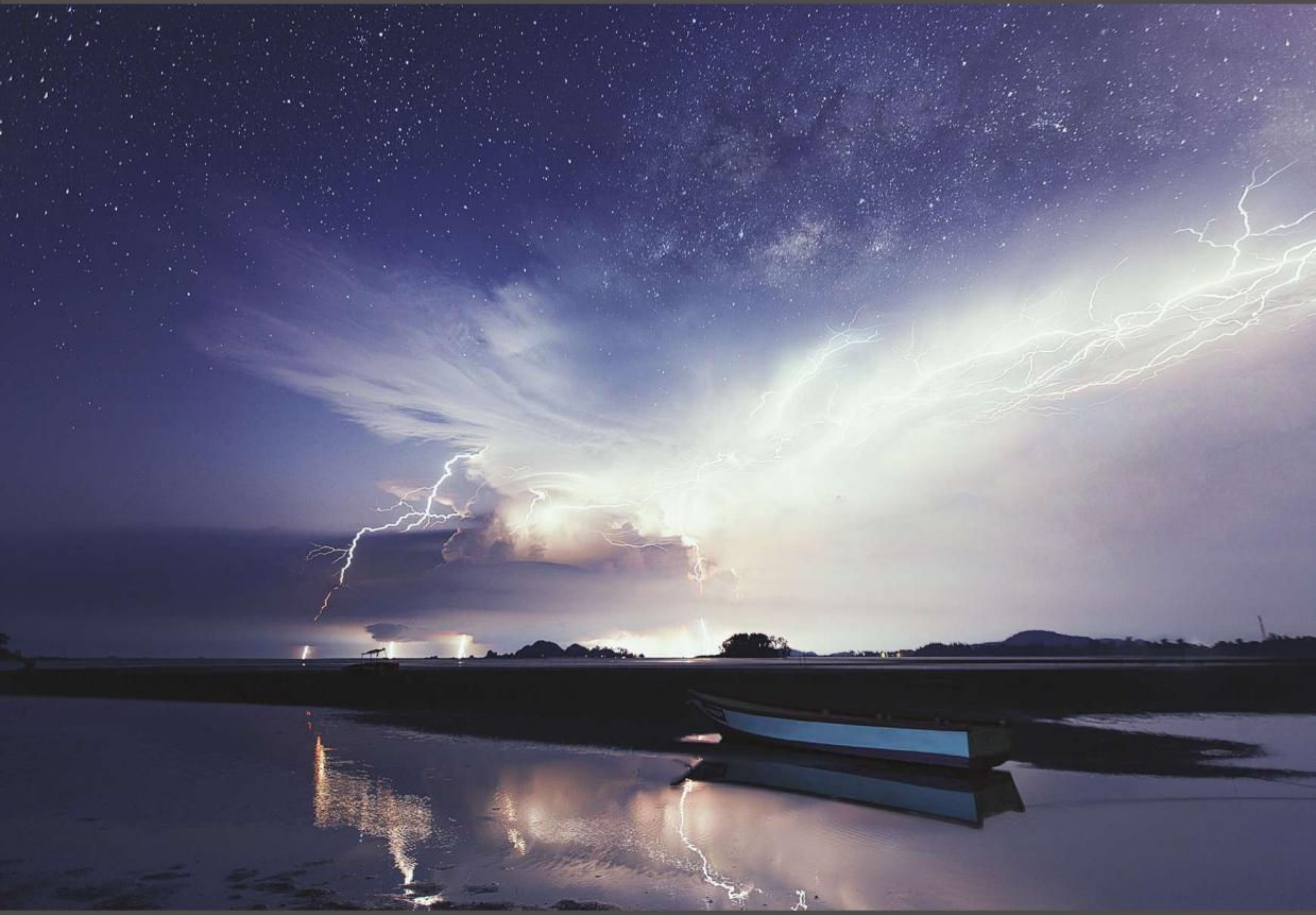
Equipment: Canon EOS 5D DSLR camera, 17mm lens.

▼ THE MILKY WAY ABOVE LIGHTNING

JUSTIN NG, MERSING, MALAYSIA,
28 JUNE 2014

Justin says: "Knowing that the sky would clear after sunset, I led a group to this location to film a timelapse of the rising Milky Way. We were treated to a spectacular lightning display for about an hour, before the clouds caught up with the Milky Way and eventually dominated the skies."

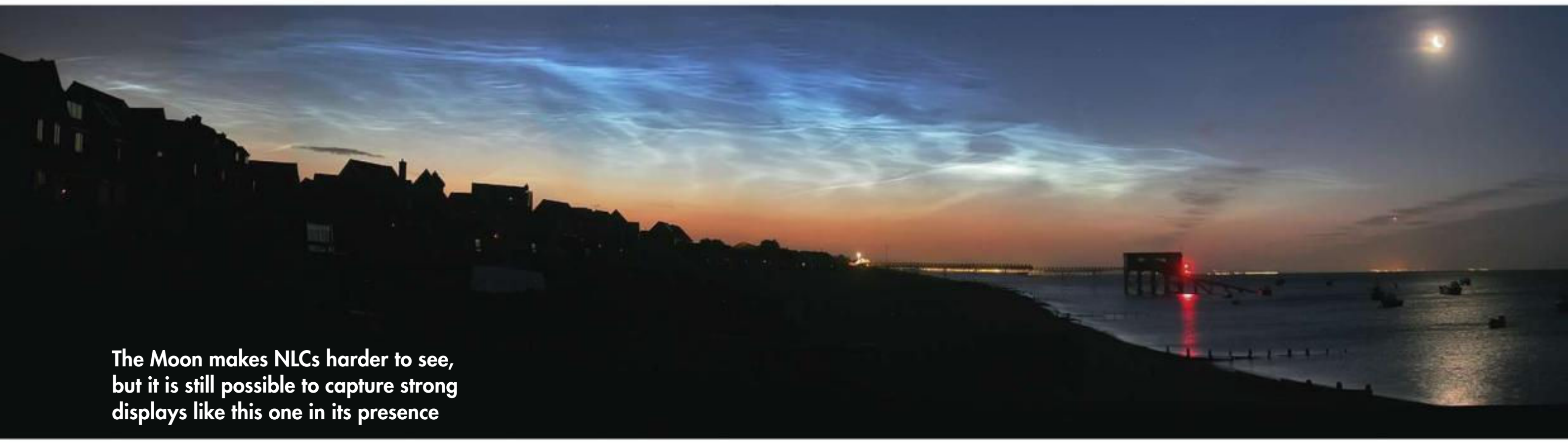
Equipment: Canon EOS 5D MK II DSLR camera, 16-35mm f/2.8 lens.



ASTROPHOTOGRAPHY TUTORIAL

WORDS: PETE LAWRENCE

NOCTILUCENT CLOUDS


The Moon makes NLCs harder to see, but it is still possible to capture strong displays like this one in its presence

RECOMMENDED EQUIPMENT

DSLR with a wide- or mid-angle lens, tripod, remote shutter release cable

Noctilucent clouds (NLCs) are the highest clouds in Earth's atmosphere, forming in a narrow layer within the mesosphere 76-85km up. Photographing them is actually quite straightforward, requiring little more than a tripod-mounted camera with a wide-angle lens. If your camera has manual control options, the lens should initially be fully opened (low f/number), set to manual focus and pre-focused at infinity. The camera should be set to a reasonably high ISO, around 400-800, and be capable of exposures of up to 10 seconds.

The most difficult aspect of imaging NLCs is getting into the habit of actually looking for them in the first place. Their low altitude means they can be hidden behind buildings or trees, and finding a location with a flat northwest to north horizon for a pre-midnight hunt and a flat north to northeast horizon for the dawn watch is imperative.

Noctilucent clouds appear between late May and early August, when the temperature at their altitude falls below –120°C. The clouds form from water vapour condensing on tiny fragments, possibly from meteor trails.

How the water vapour gets up there is more complex and is now thought to be the result of some complicated chemistry, possibly connected with climate change. So when you see a beautiful display of NLCs, it may also be an indication that something unusual is happening to our climate. This also adds a layer of scientific importance to observing and imaging them – so make sure you mark the date and time on any photos you capture, as well as recording the location from which you took them.

Night-shining

NLCs shine because they are high enough that they reflect the sunlight even when our star is between 6° and 16° below the horizon. In this state, normal 'tropospheric' clouds remain dark. If any of these clouds pass by when a bright NLC display is in full swing, they can appear silhouetted against the bright and much higher NLCs.

NLC displays vary in intensity from very weak, hardly discernible wisps to full-on glowing networks of electric-blue clouds bright enough to spark erroneous reports that the aurora is visible. If you get a full-on display then you may be able to rely on some of your camera's automatic functions, for example auto-focus.

To start, take a five-second test exposure with the ISO set at 800 and examine the result on your camera's review screen. If it is too bright and contains white, then the image is overexposed. Use your camera's histogram display (if it has one) to confirm this. The histogram will show a sharp 'cliff' at the white end of the graph if the image is overexposed. If the cliff is shown towards the black end of the histogram – in other words, if the image contains black – then it is underexposed.

To correct overexposure, drop the ISO or the exposure time. You could also try stopping your lens down by a stop or two. Dropping the ISO should mean the delicate tones of the scene should render better. To correct for underexposure increase the ISO or the exposure time. Increasing exposure is preferable in this case, as the latter will reduce tonal quality and increase image noise.

In order to catch a good display, you'll need to be vigilant and look out each evening – and preferably in the morning too. Fortunately, the short nights of June and July don't make this too much of a chore. Although the presence of a bright Moon will make NLCs harder to see, the waning crescent phases may be positioned so that the Moon's disc is behind an extensive display. If this occurs, the thin-film nature of the NLC layer amazingly doesn't do much to the moonlight that passes through it – there is no real scattering of light around the Moon's disc.

KEY TECHNIQUE

If you do get to see a noctilucent cloud display there is a good chance that the scene will be too wide for your camera. With your camera levelled, it is a relatively easy job to take the shots necessary to create a panorama of the display. Although this can be done manually (by carefully making sure you keep a bit of silhouetted horizon in the shot) there's an automated method using the free-to-download Microsoft Image Composite Editor that can really take the hard work out of the process.

ALL PICTURES: PETE LAWRENCE

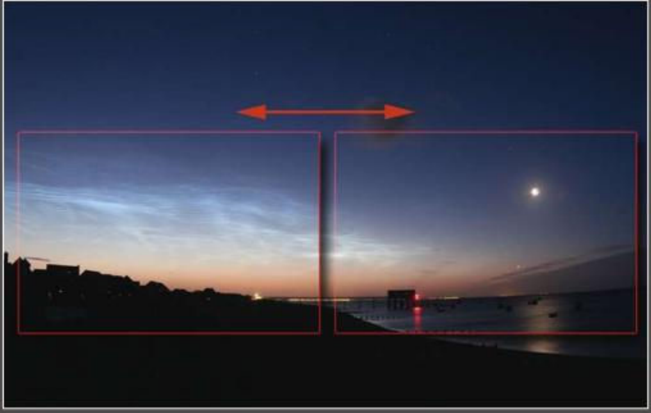
STEP BY STEP GUIDE

STEP 1

For evening NLCs you need somewhere with a relatively flat and dark view of the north and northwest horizons; it's the same for morning NLCs but facing north and northeast. Aim to check the evening site between 22:00-00:00 BST (21:00-23:00 UT) and the morning site between 02:00-04:00 BST (01:00-03:00 UT).

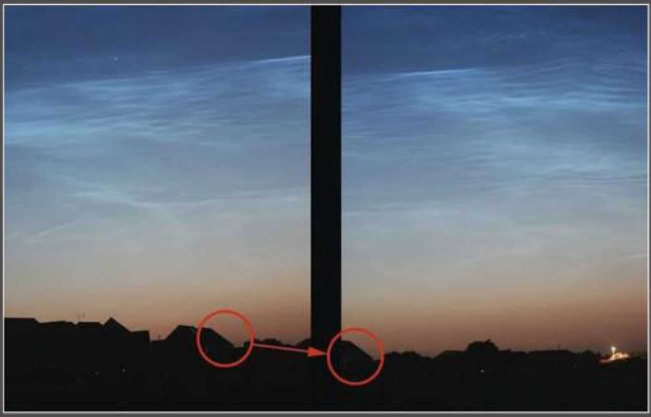
STEP 2

Imaging NLCs requires nothing more complicated than a camera on a tripod, though we'd recommend a remote shutter release cable so you can take shots without wobbling the camera. The camera needs some manual settings for you to get the best shots, but a big NLC display may be bright enough for a basic point and shoot camera.



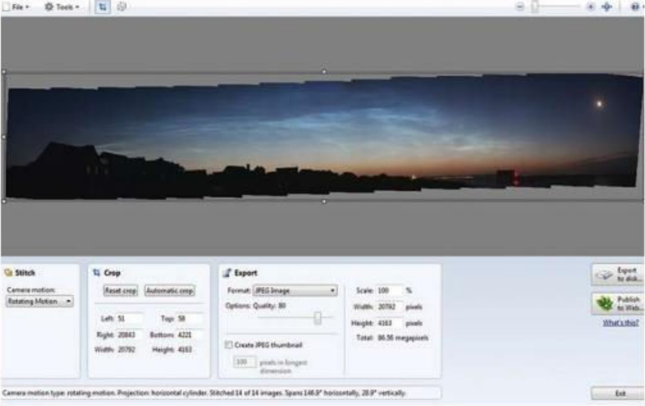
STEP 3

The tripod should be on level ground and the camera aligned so that the bottom edge of the image frame is parallel to the horizon. Once you've done this pan the camera left and right to make sure it doesn't wander up or down. If you've got it right, the bottom of the image frame and the horizon should remain parallel.



STEP 4

Aim your camera at one extremity of the display and include a bit of silhouetted horizon for scale. Take a shot. Using something on the horizon as a guide, move the camera sideways, keeping an overlap of 25 per cent between frames. Repeat until you capture the entire display. If the display is high, consider taking portrait shots.



Camera motion: Rotating Motion

Left: 51 Top: 58
Right: 20843 Bottom: 4221
Width: 20792 Height: 4163

Format: JPEG Image
Options: Quality: 80

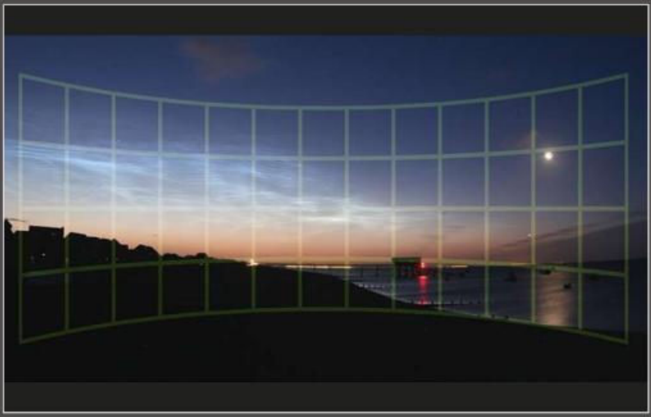
Scale: 100 %
Width: 20792 pixels
Height: 4163 pixels
Total: 86.56 megapixels

100 pixels in longest dimension

Camera motion type: rotating motion. Projection: horizontal cylinder. Stitched 14 of 14 images. Spans 146.0° horizontally, 28.9° vertically.

STEP 5

You can join the images together manually, but a simpler method is to download a freeware panorama creator such as Microsoft's Image Composite Editor (see http://bit.ly/ICE_mosaic). Once installed, the display files can be dragged into the program's main window and it will then do all the hard work for you.



STEP 6

If the NLC display is bright enough, you may be able to record an image with the panoramic imaging function on a smartphone. In any case, camera phones continue to improve in quality, so if you don't have a regular camera it is worth trying your phone to see if you can record the display.

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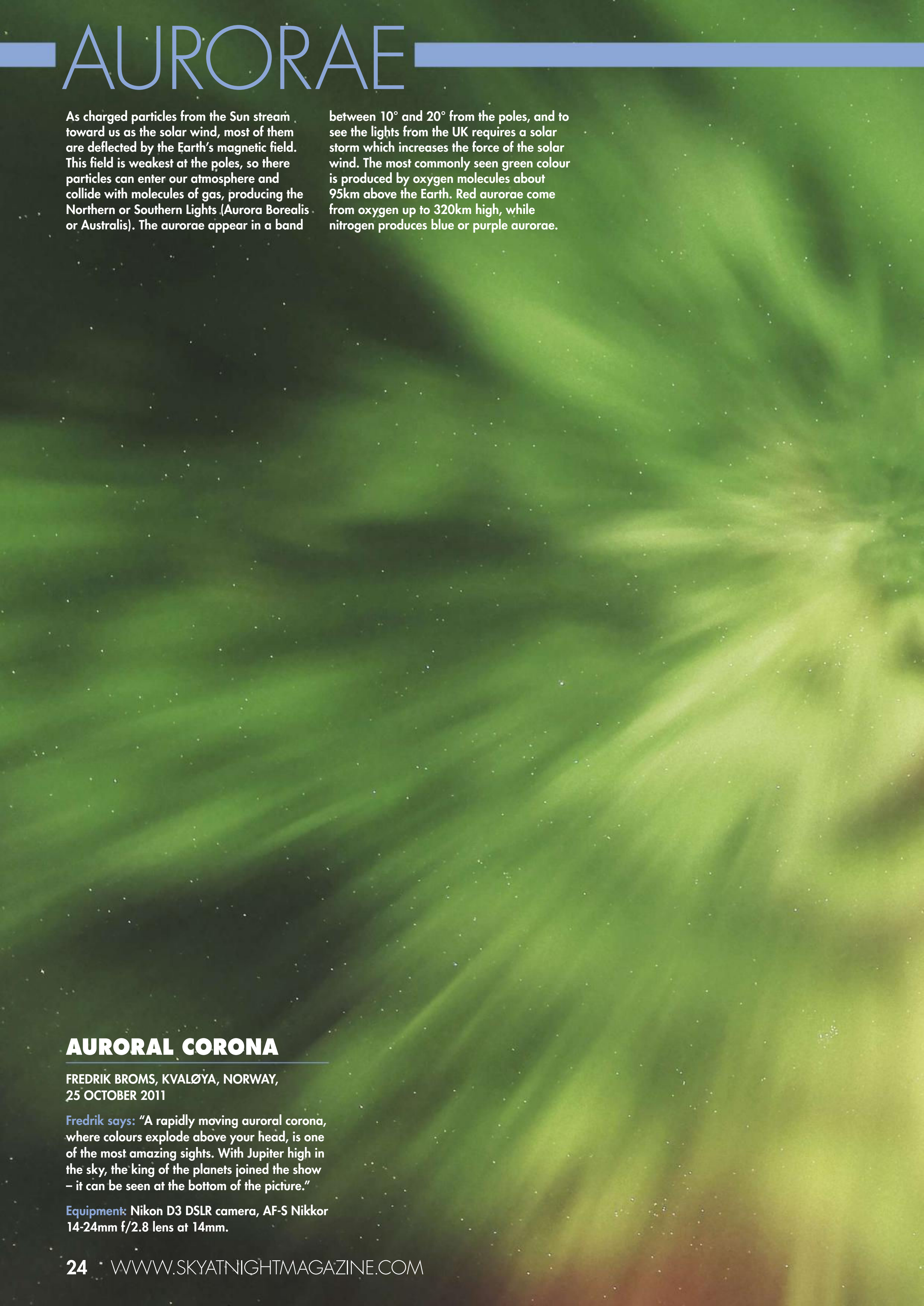
AURORAE

As charged particles from the Sun stream toward us as the solar wind, most of them are deflected by the Earth's magnetic field. This field is weakest at the poles, so there particles can enter our atmosphere and collide with molecules of gas, producing the Northern or Southern Lights (Aurora Borealis or Australis). The aurorae appear in a band between 10° and 20° from the poles, and to see the lights from the UK requires a solar storm which increases the force of the solar wind. The most commonly seen green colour is produced by oxygen molecules about 95km above the Earth. Red aurorae come from oxygen up to 320km high, while nitrogen produces blue or purple aurorae.

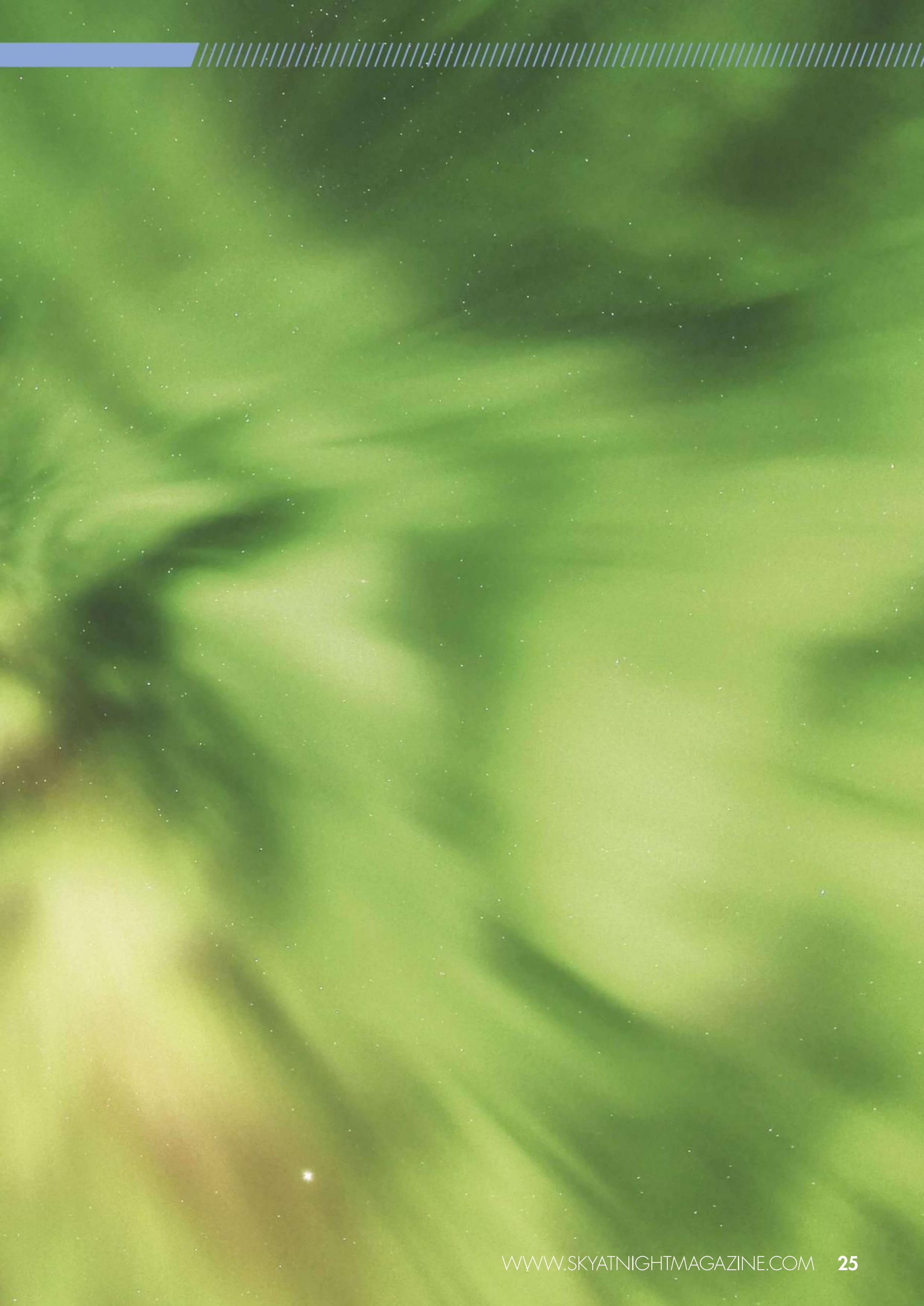


AURORAL CORONA

FREDRIK BROMS, KVALØYA, NORWAY,
25 OCTOBER 2011

Fredrik says: "A rapidly moving auroral corona, where colours explode above your head, is one of the most amazing sights. With Jupiter high in the sky, the king of the planets joined the show – it can be seen at the bottom of the picture."

Equipment: Nikon D3 DSLR camera, AF-S Nikkor 14-24mm f/2.8 lens at 14mm.

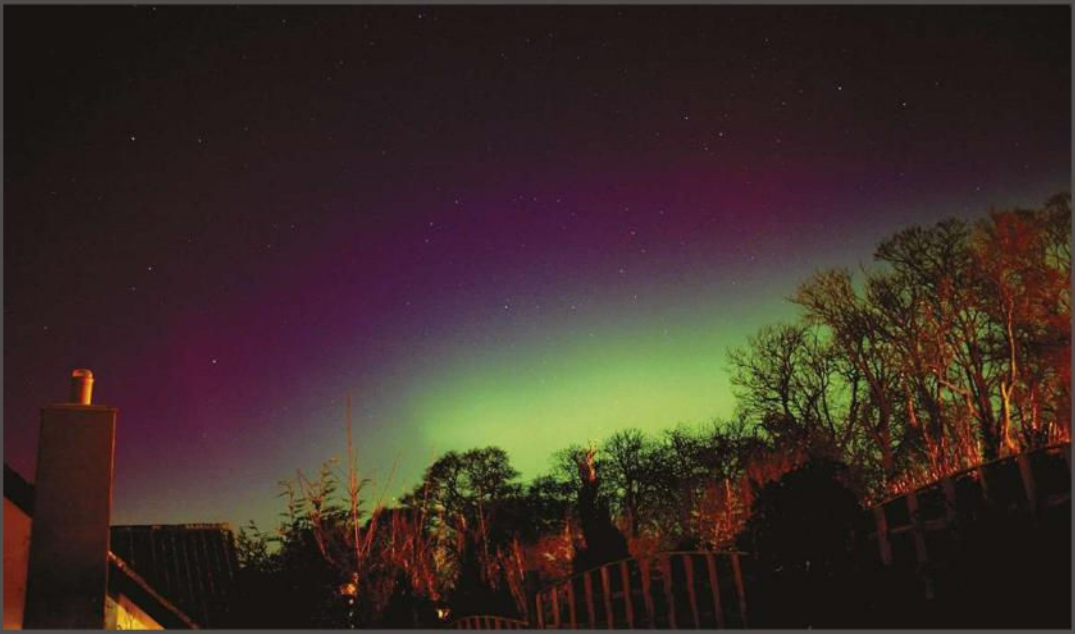


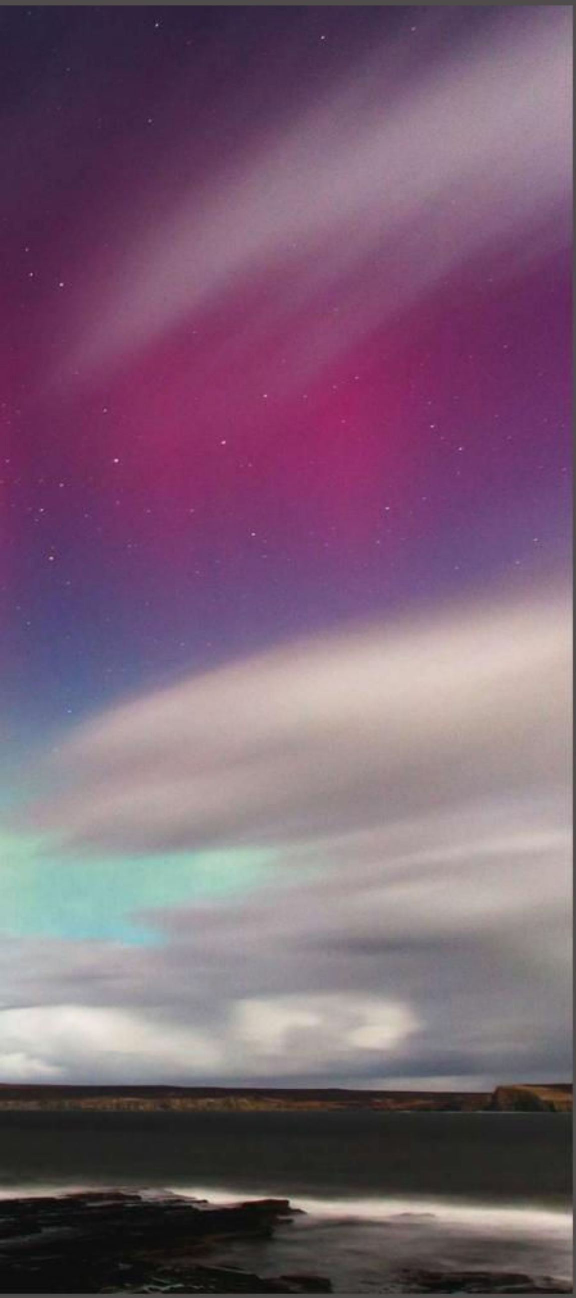
GARDEN AURORA ▶

RICHARD DAVIS, ARTHINGTON, WEST YORKSHIRE, 21 JANUARY 2005

Richard says: "This image was taken on a 30 second exposure from my back garden."

Equipment: Canon EOS 300D DSLR camera, 18-55mm lens at 18mm.





◀ THURSO, SCOTLAND

GORDON MACKIE, THURSO, SCOTLAND, 15 FEBRUARY 2014

Gordon says: "This image was taken during a fleeting gap in the clouds. I was fortunate that the strong glare from the full Moon was partly shaded by a thin layer of cloud when I was taking this shot, allowing for a slightly longer exposure to help the aurora stand out without washing out the foreground."

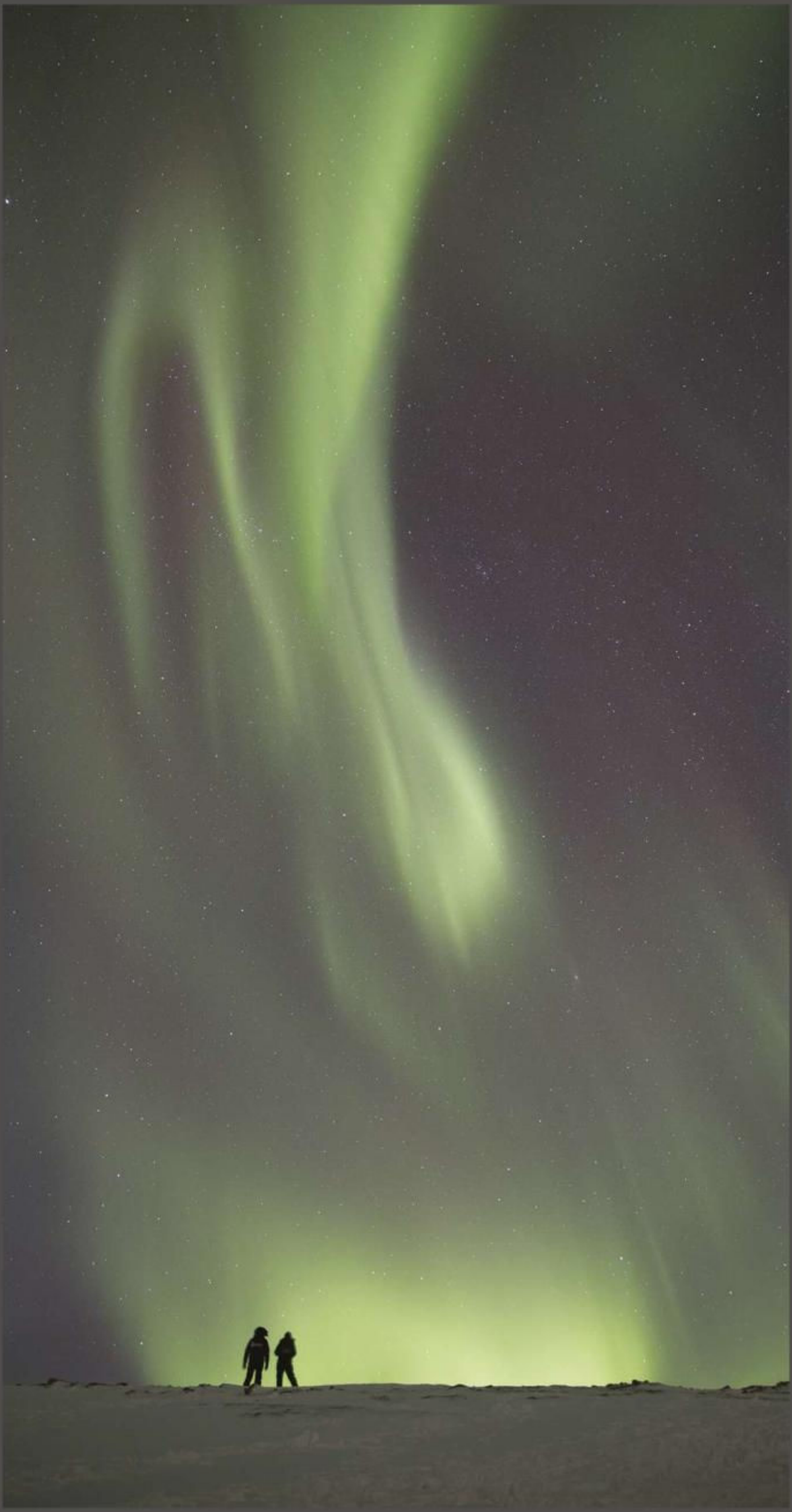
Equipment: Canon EOS 650D DSLR camera, 10-20mm lens at 10mm and f/3.5.

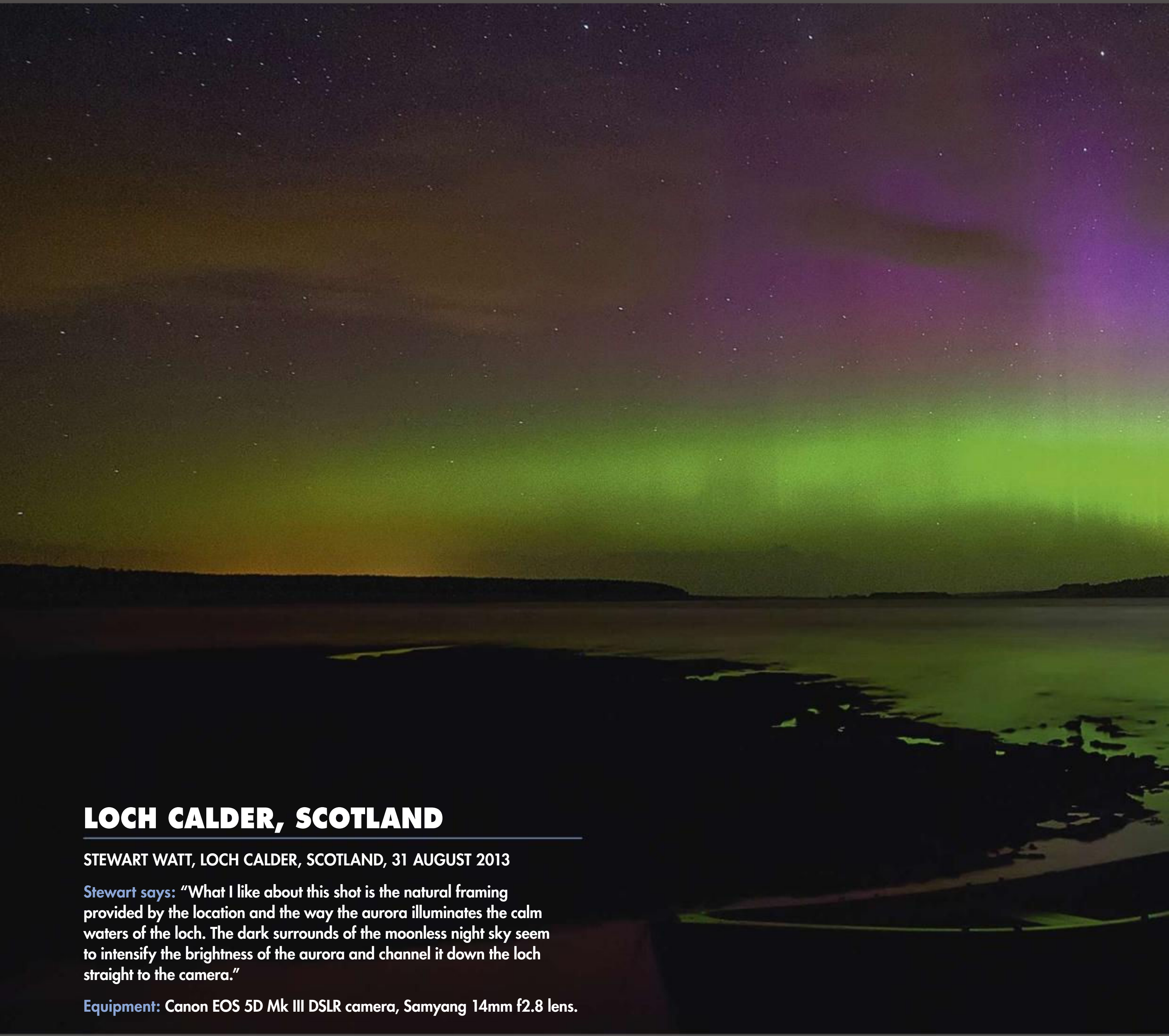
ABISKO, SWEDEN ▶

MIKE MORLEY, ABISKO, SWEDEN,
19 JANUARY 2015

Mike says: "We were lucky enough to get married in northern Sweden and returned for our 10th anniversary in January 2015. We took an open chairlift up 900m to view the aurora from a mountaintop and only had one night to catch it. I spotted these two tourists and thought they would provide good scale against the lights, so I repositioned my tripod. It felt like we were right inside the aurora."

Equipment: Canon EOS 6D DSLR camera, 24-70mm lens at 24mm and f/2.8.



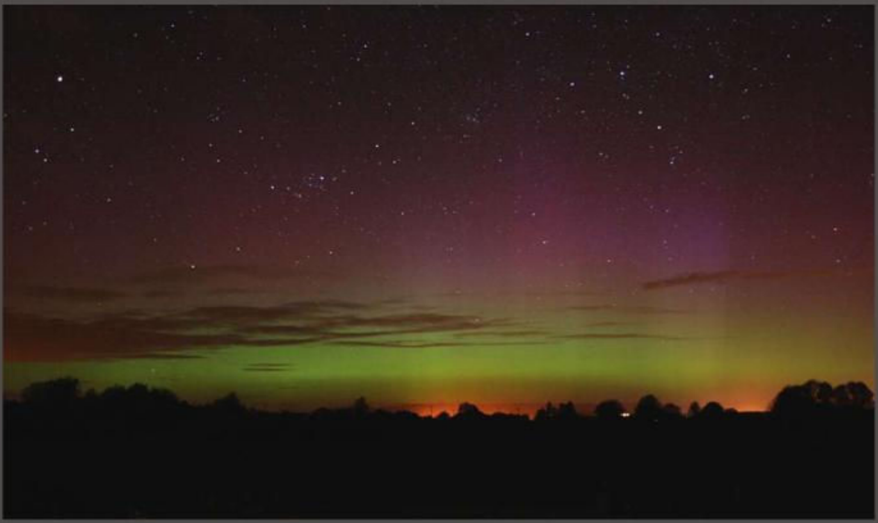


LOCH CALDER, SCOTLAND

STEWART WATT, LOCH CALDER, SCOTLAND, 31 AUGUST 2013

Stewart says: "What I like about this shot is the natural framing provided by the location and the way the aurora illuminates the calm waters of the loch. The dark surrounds of the moonless night sky seem to intensify the brightness of the aurora and channel it down the loch straight to the camera."

Equipment: Canon EOS 5D Mk III DSLR camera, Samyang 14mm f2.8 lens.

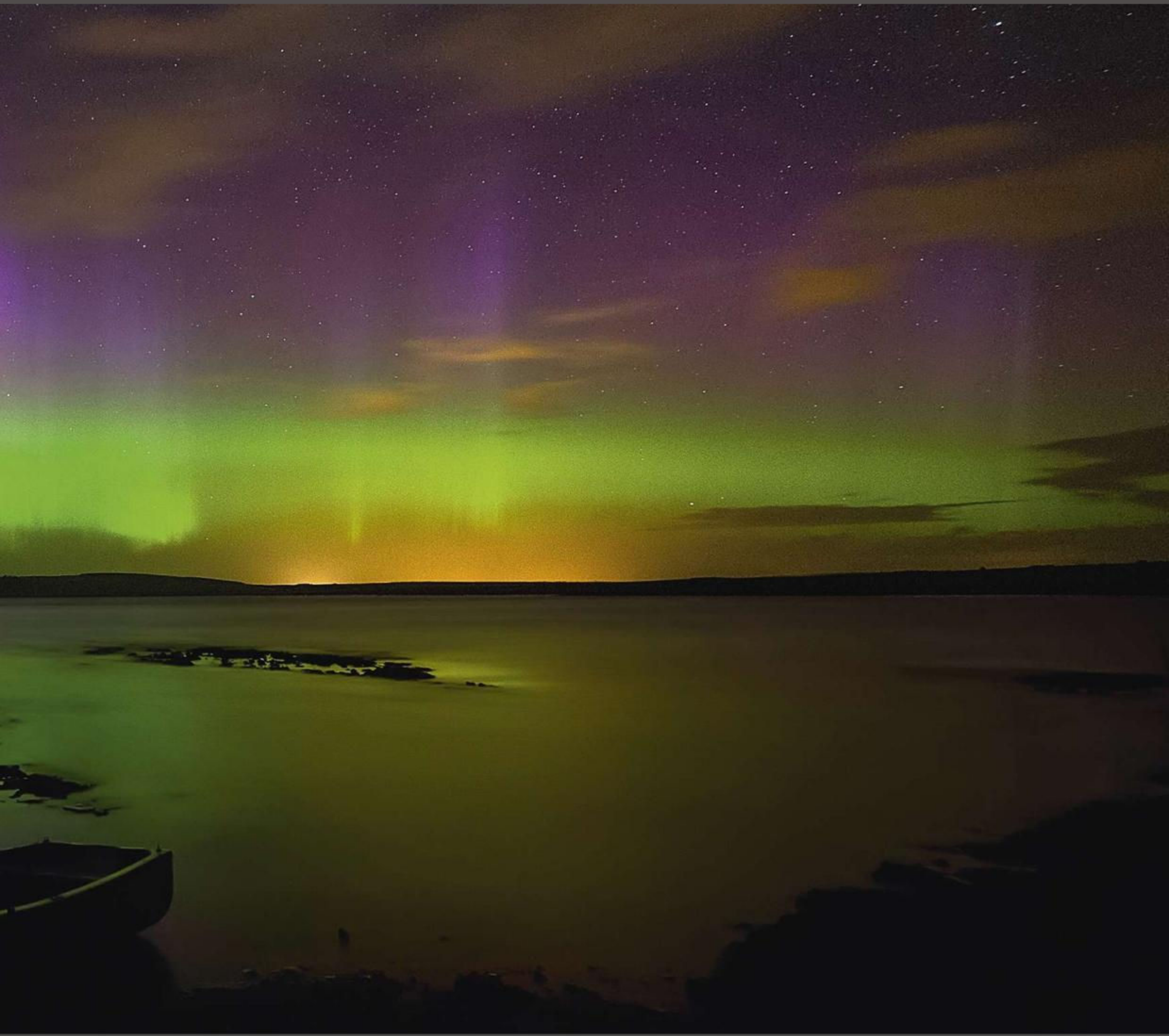


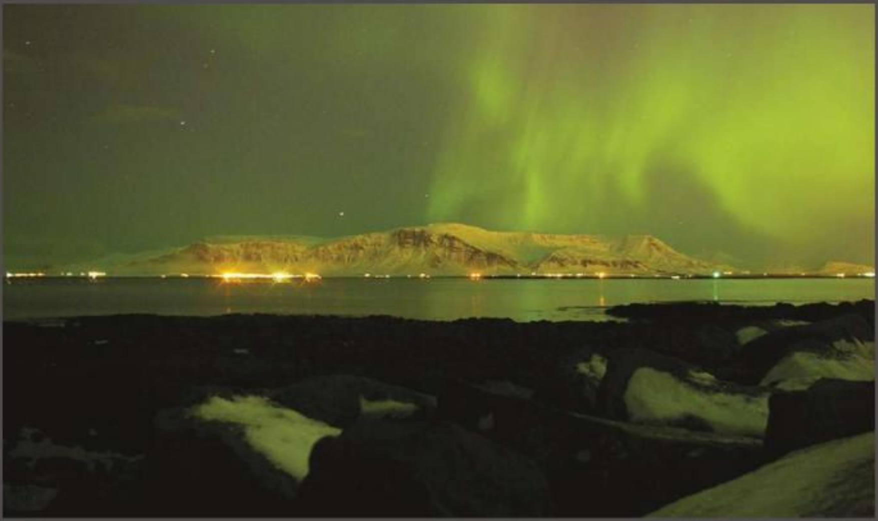
◀ IRELAND

RONAN NEWMAN, IRELAND, 13 APRIL 2012

Ronan says: "The equinox lived up to expectations and delivered us a lovely auroral substorm here on the west coast of Ireland. We had been waiting eight years for such an event, and nature finally gave us a treat. A coronal hole caused a solar wind stream to hit Earth's magnetic field on 13 April, sparking a geomagnetic storm."

Equipment: Canon EOS 400D DSLR camera.



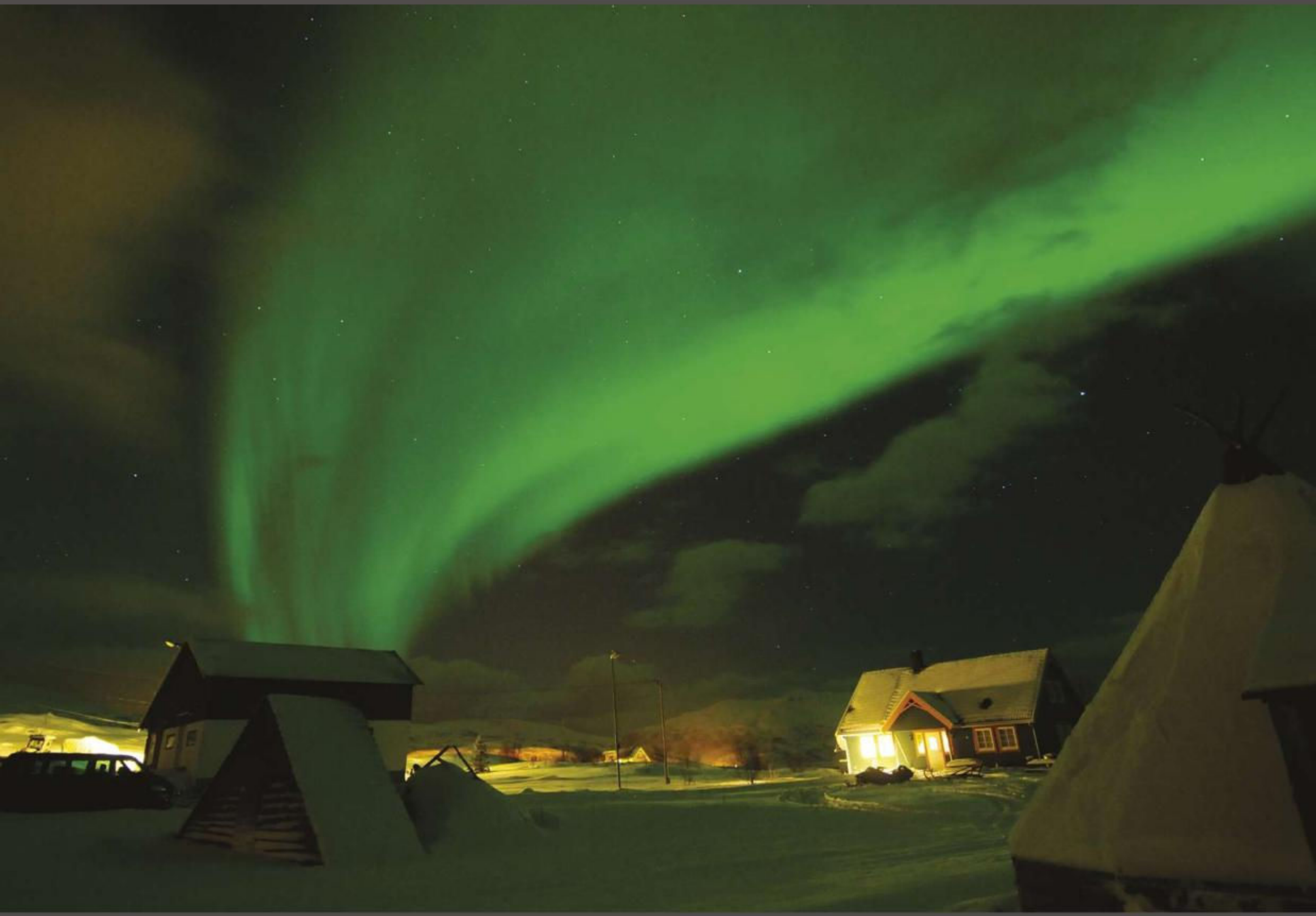


◀ ICELAND

DAVE STOCKS, REYKJAVIK, ICELAND, 22 JANUARY 2012

Dave says: "What a way to spend my 50th birthday. The auroral display on the night was very dynamic, changing from static to pulsating bands, and at one stage it looked as if we were about to experience a shower of green snow!"

Equipment: Samsung GX10 DSLR camera.



▲ TROMSØ, NORWAY

RUSSELL BENNETT, TROMSØ, NORWAY, JANUARY 2011

Russell says: "I was amazed at how well this image came out with absolutely no manipulation. It would have been impossible with the old slide film I used to use. It just shows that with a bit of thought an astrophotography virgin like myself can knock out a decent shot."

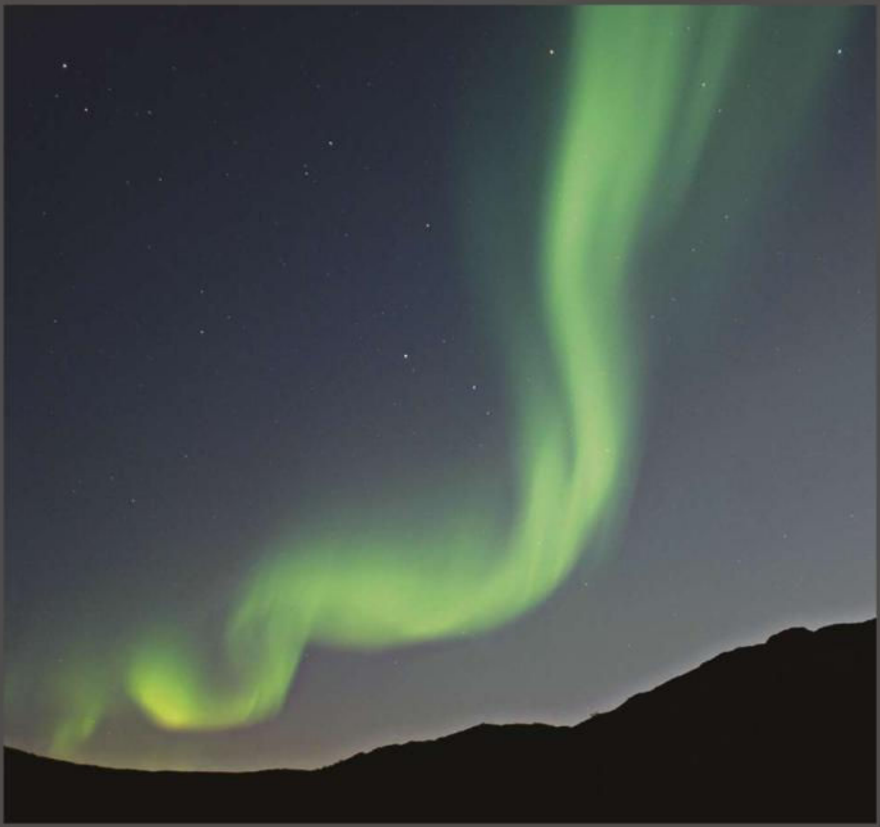
Equipment: Nikon D300s DSLR camera, lens at 12mm and f/4.

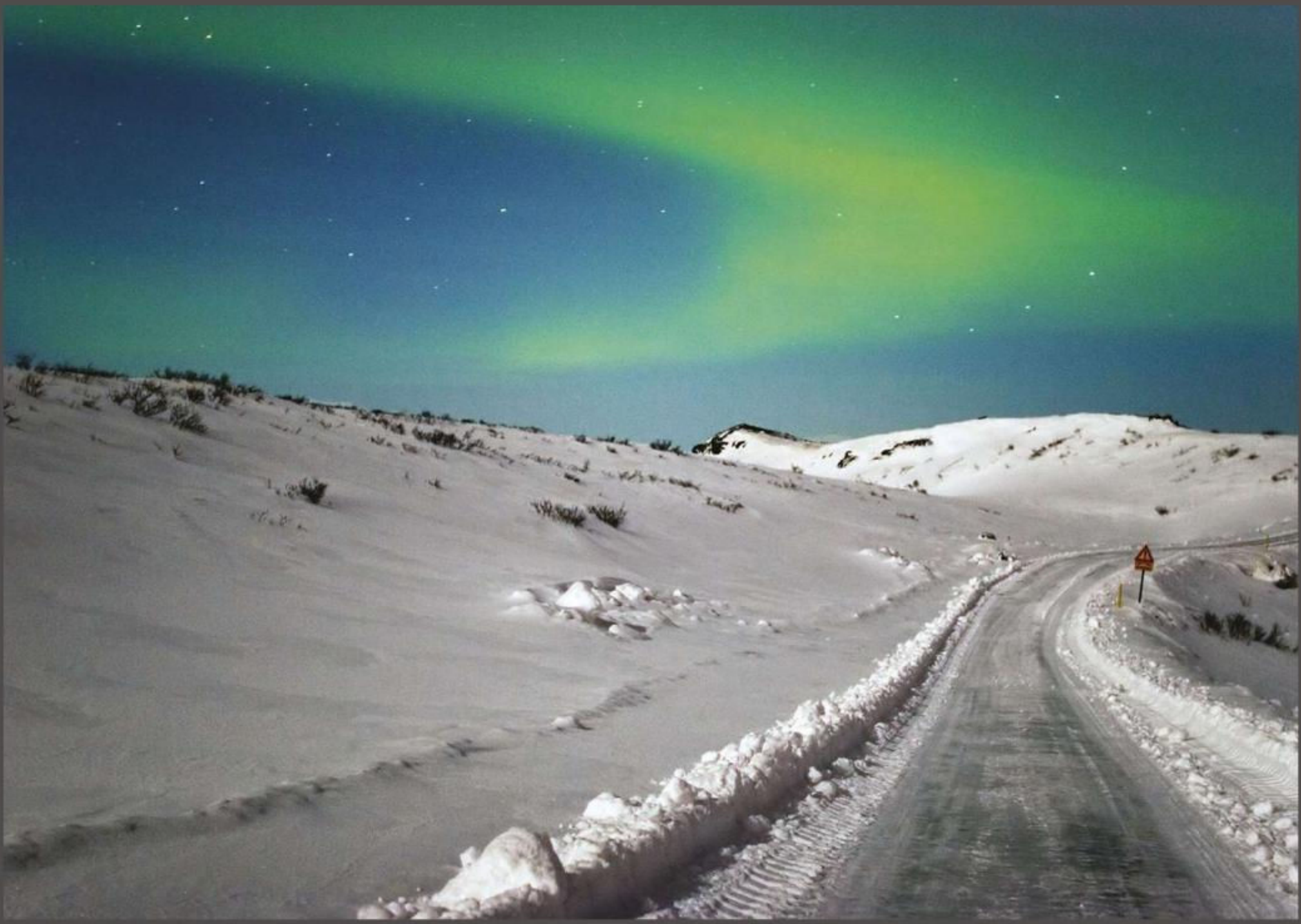
KVALØYA, NORWAY ▶

FREDRIK BROMS, KVALØYA, NORWAY, 14 SEPTEMBER 2008

Fredrik says: "With the rapid movement of the Northern Lights, composition can be tricky, but I especially like how cleanly this picture came out, with the band of aurorae stretching over the mountain silhouette."

Equipment: Nikon DSLR camera, Nikkor AF 20mm lens.





▲ THINGVALLAVATN, ICELAND

GREG BEEKE, THINGVALLAVATN RIFT VALLEY LAKE, ICELAND, 12 FEBRUARY 2008

Greg says: "The image was taken during a family holiday to Iceland. One of our aims was to see the Aurora Borealis, but the weather forecast wasn't promising. We booked a tour and were fortunate that the clouds broke to reveal a spectacular display that lasted a couple of hours."

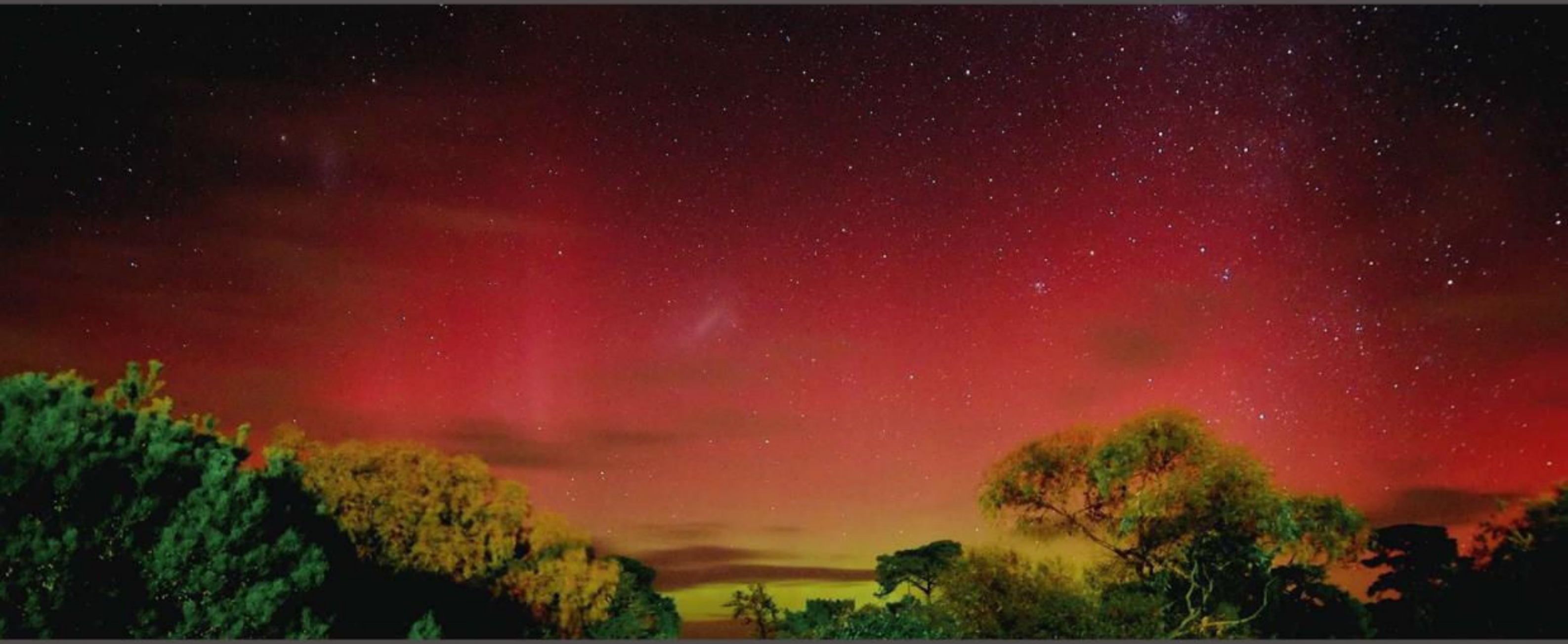
Equipment: Canon 20D DSLR camera, Pentax 35mm f/2 lens.

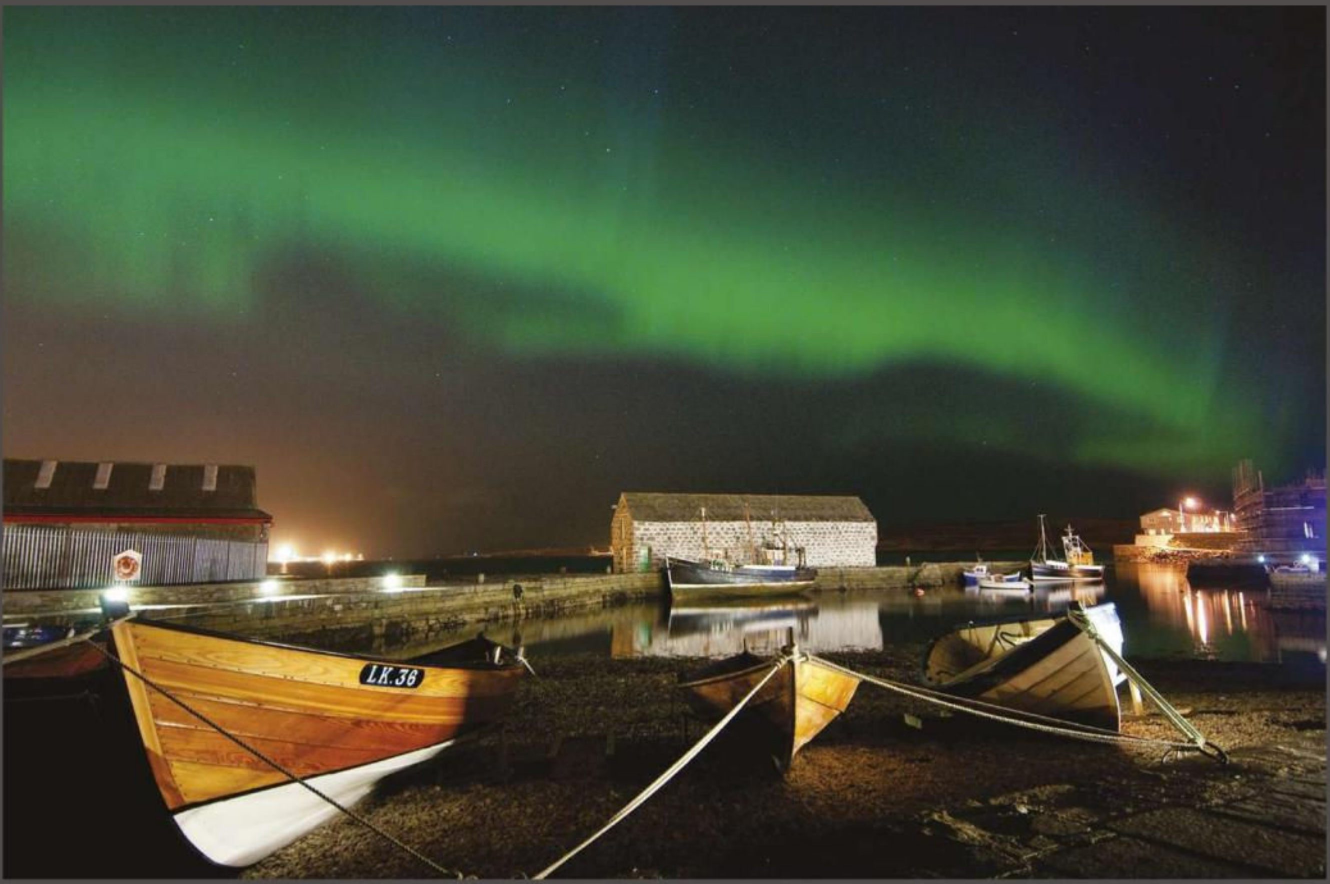
▼ VICTORIA, AUSTRALIA

PAUL ALBERS, VICTORIA, AUSTRALIA, 15 JULY 2012

Paul says: "This picture was taken from my back veranda after the X1.4 solar flare we had on 12 July 2012. I was able to see the aurora with the naked eye, so I decided to set the camera up. The aurora lasted most of the night so the family managed to see it too, though they were disappointed they couldn't see the details the camera captured."

Equipment: Pentax K-x DSLR camera, Samyang 14mm lens at f/2.8.





▲ SHETLAND

AUSTIN TAYLOR, SHETLAND, 12 APRIL 2010

Austin says: "I hadn't seen a good aurora for two years and had all but given up for this season when, late on 11 April, friends started talking about sightings. In the end I was out for five hours till nearly daybreak. It was the best display I've seen since 2006."

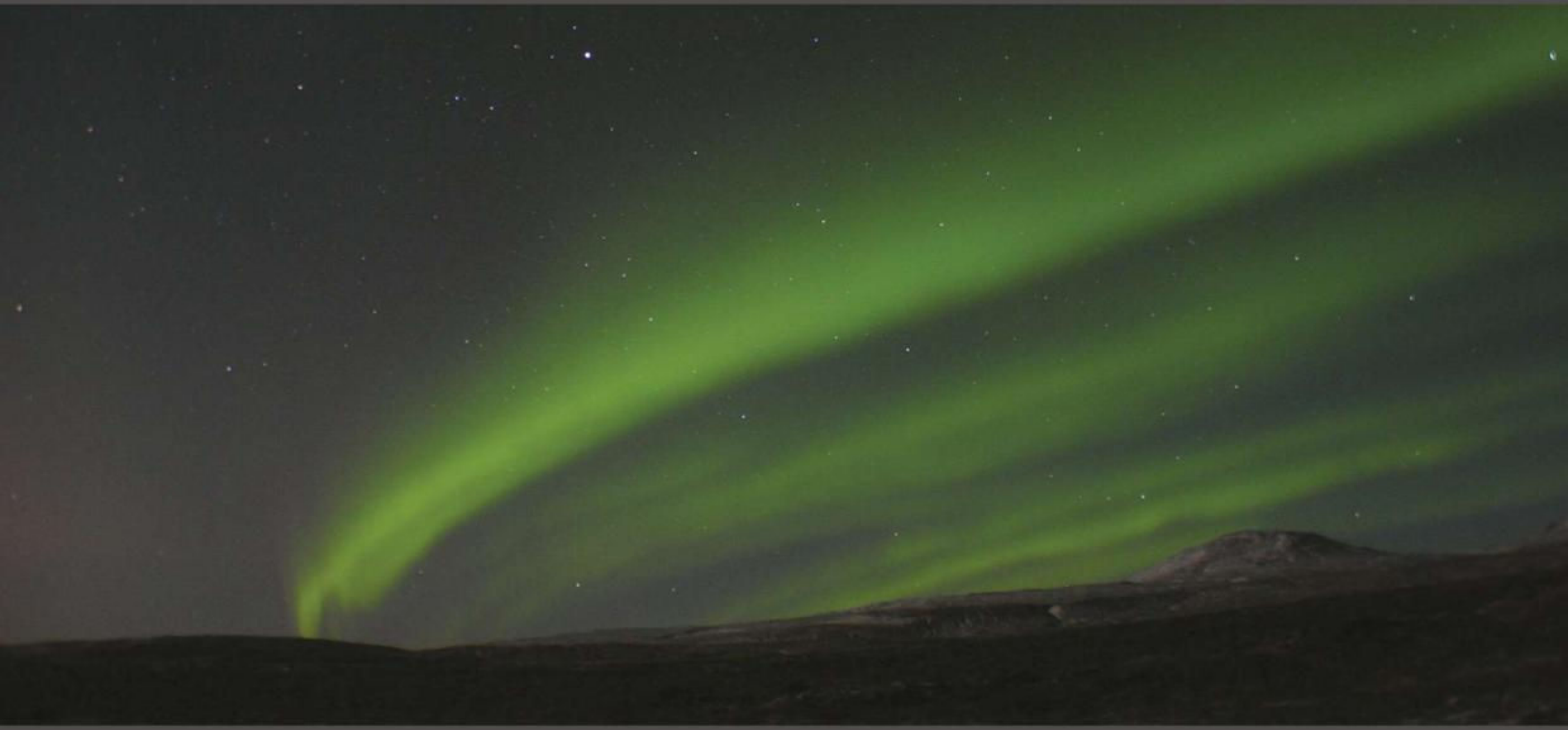
Equipment: Nikon D300 DSLR camera, Nikkor 12-24mm lens at 13mm and f/4.

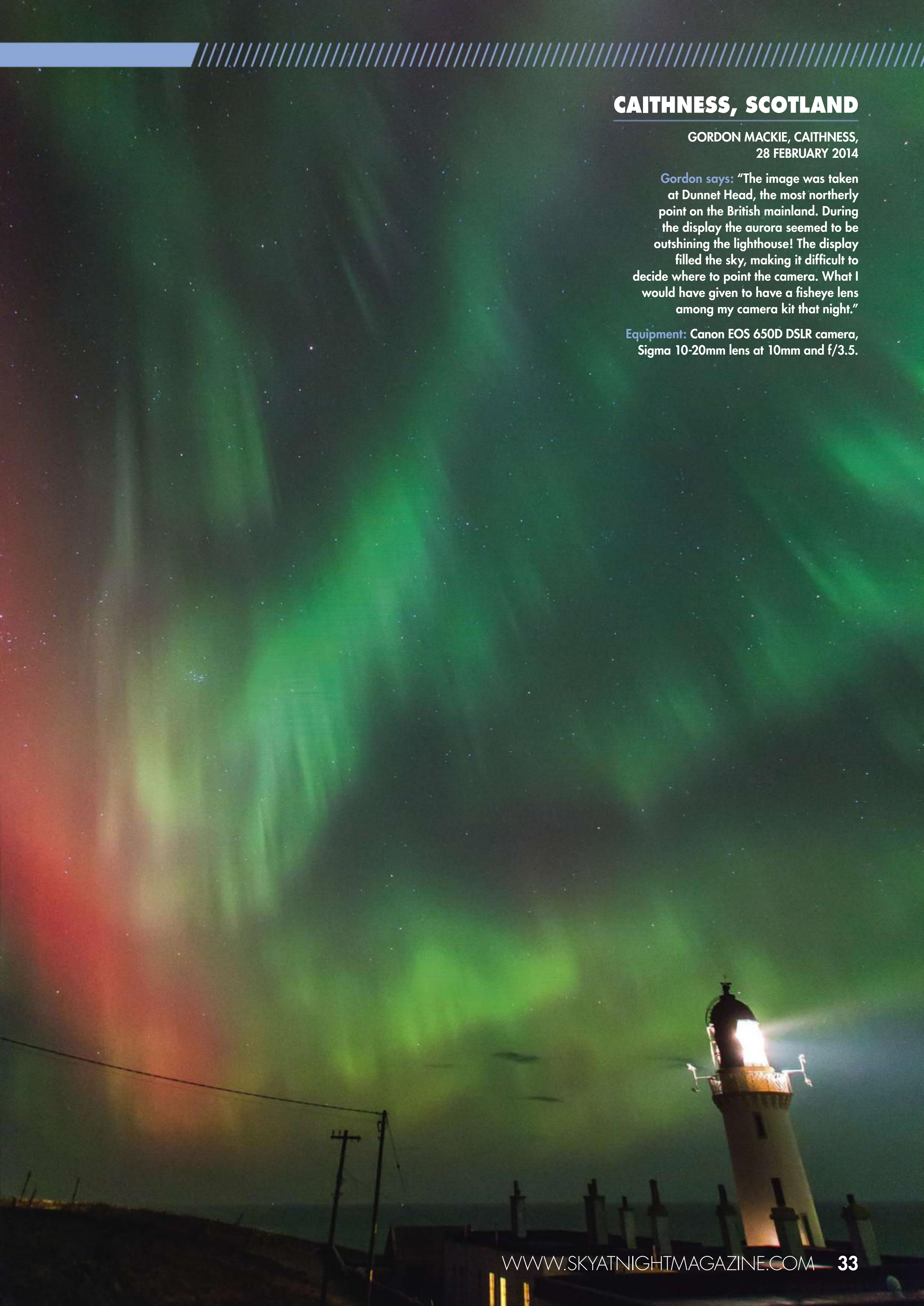
▼ THINGVELLIR, ICELAND

DAVID STRANGE, THINGVELLIR NATIONAL PARK, ICELAND,
14 NOVEMBER 2010

David says: "This is a 25-second exposure on an AstroTrac mount. The aurorae resulted from a C4-class solar flare from sunspot 1123 on 12 November, which luckily coincided with clear skies for our four-day trip to Iceland."

Equipment: Canon EOS 300D DSLR camera, lens at 18mm and f/3.5.



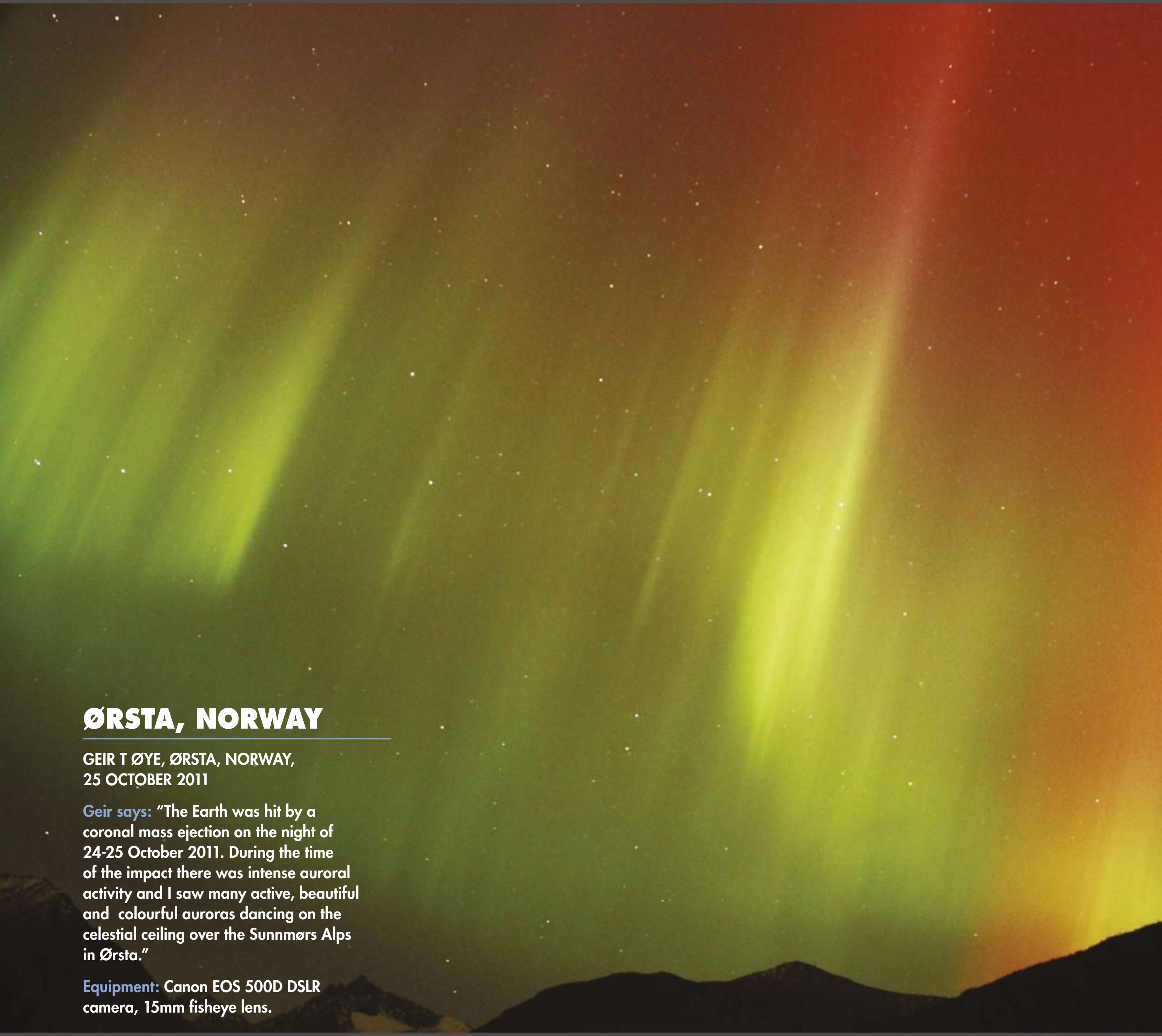


CAITHNESS, SCOTLAND

GORDON MACKIE, CAITHNESS,
28 FEBRUARY 2014

Gordon says: "The image was taken at Dunnet Head, the most northerly point on the British mainland. During the display the aurora seemed to be outshining the lighthouse! The display filled the sky, making it difficult to decide where to point the camera. What I would have given to have a fisheye lens among my camera kit that night."

Equipment: Canon EOS 650D DSLR camera, Sigma 10-20mm lens at 10mm and f/3.5.

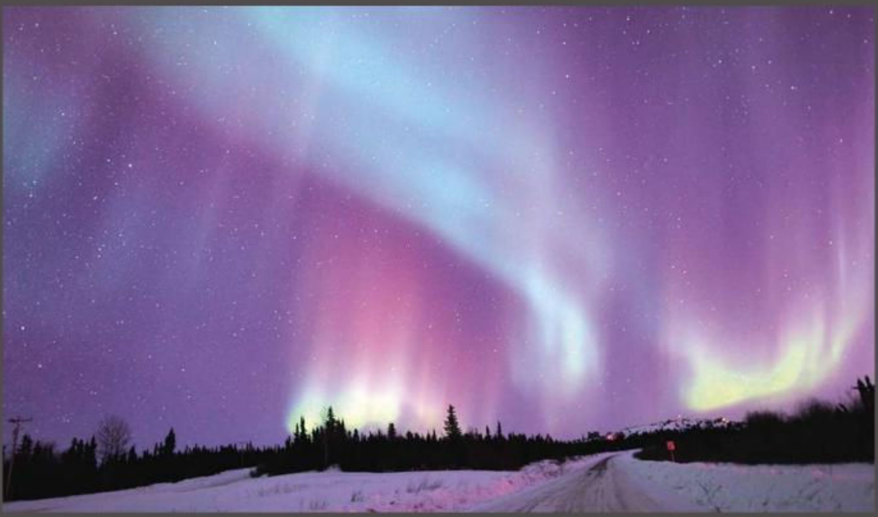


ØRSTA, NORWAY

GEIR T ØYE, ØRSTA, NORWAY,
25 OCTOBER 2011

Geir says: "The Earth was hit by a coronal mass ejection on the night of 24-25 October 2011. During the time of the impact there was intense auroral activity and I saw many active, beautiful and colourful auroras dancing on the celestial ceiling over the Sunnmørs Alps in Ørsta."

Equipment: Canon EOS 500D DSLR camera, 15mm fisheye lens.

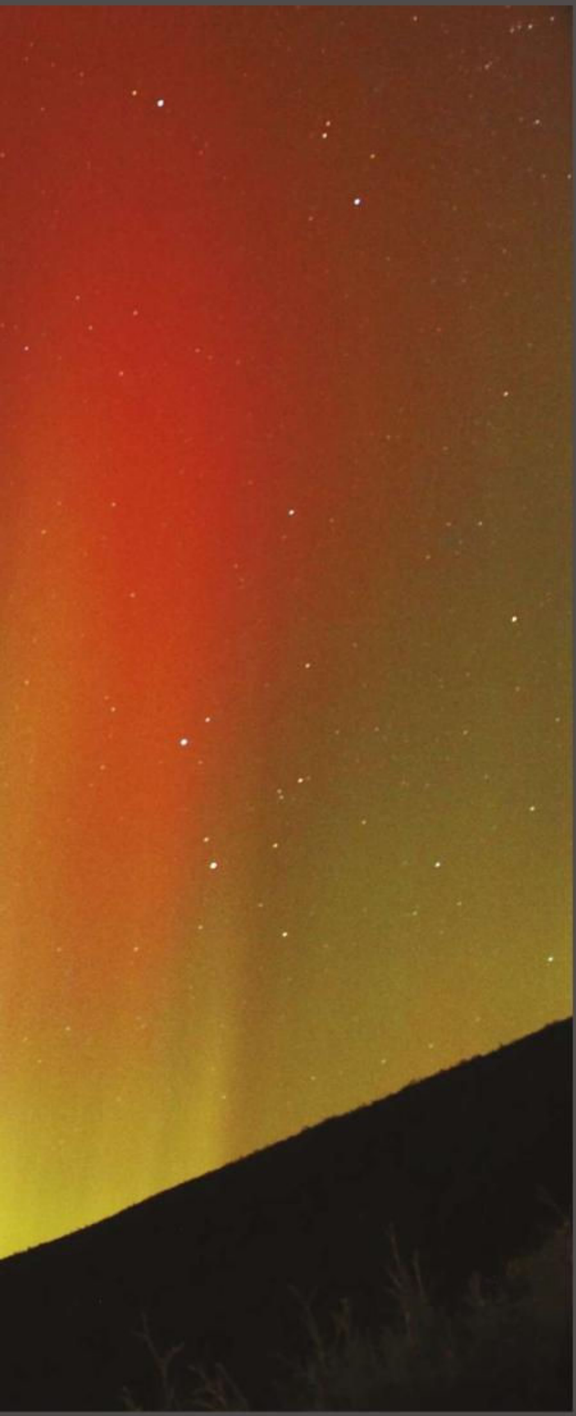


◀ ALASKA, USA

JOHN CHUMACK, ALASKA, 21 MARCH 2014

John says: "I spent a week in Chena Hot Springs and Fairbanks in Alaska, observing the aurora until four in the morning! The KP index was at three or four on most nights, and the Northern Lights were very active on several. This aurora image occurred on the night of the equinox."

Equipment: Canon EOS 5D Mk II DSLR camera, 24mm lens at f/2.

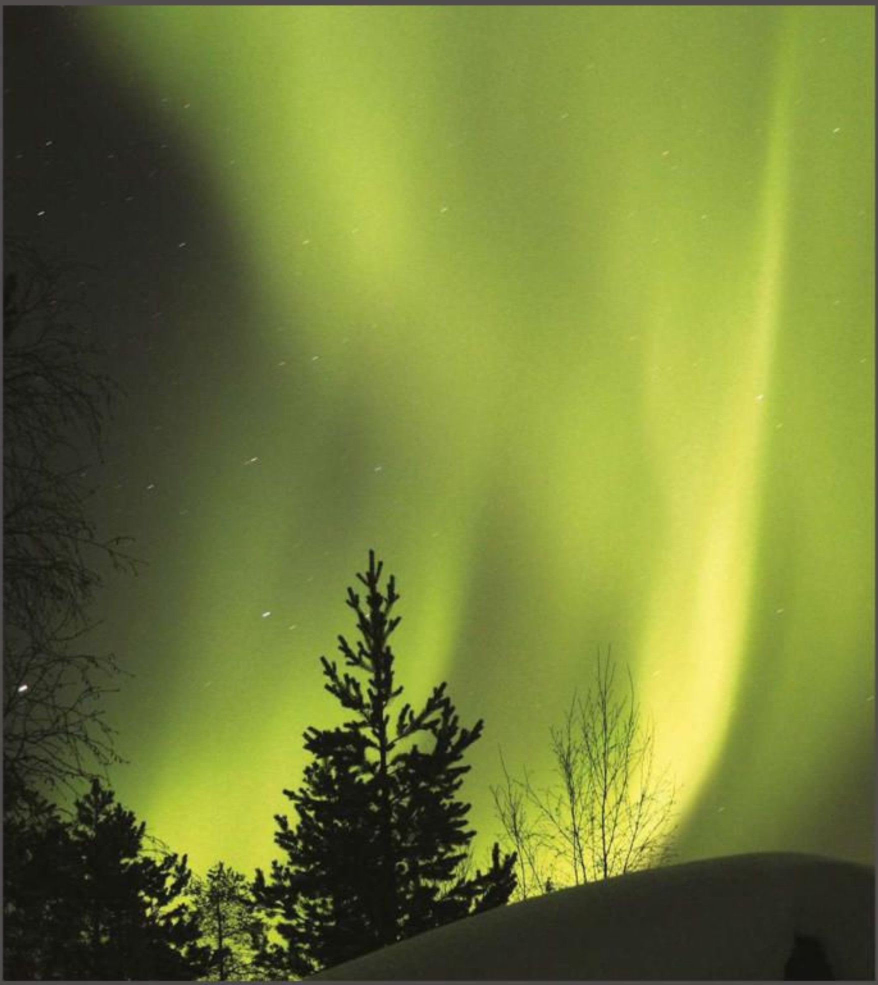


THURSO, SCOTLAND ▶

STEVEN MCCONNACH, THURSO,
17 JANUARY 2013

Steven says: "This picture shows a nice but short-lived aurora on 17 January. It was a very nice sight in the sky, I just wish it had lasted longer."

Equipment: Canon EOS 500D DSLR camera.



▲ OULANKA, FINLAND

CLIVE INGLIS, OULANKA, NORTHERN FINLAND, FEBRUARY 2010

Clive says: "We were lucky enough to see a spectacular auroral display on the first night of our stay in the Oulanka National Park in Finland this year. A truly magical experience."

Equipment: Canon EOS 450D DSLR camera, lens at 43mm and f/5.

ASTROPHOTOGRAPHY TUTORIAL

WORDS: PETE LAWRENCE

CAPTURING THE AURORA

RECOMMENDED EQUIPMENT

DSLR camera, tripod, mid- to wide-angle lens of 50mm focal length or shorter, remote shutter release cable

The aurora holds great attraction for astronomers and non-astronomers alike. The promise of bright colourful curtains of light filling the sky, swirling this way and that with searchlight beams reaching up into the heavens, is hard for anyone to resist. However, the visual reality often lags behind the expectations derived from looking at photos of the aurora in books and magazines.

To see the aurora at its very best you need to catch it when it's active and also be relatively close to it. Seen from afar, an aurora may show great structure but its colours may be weak and muted. A camera can bring a completely different view, turning the greyest of weak aurorae into a festival of colour.

The aurora occurs in a ring known as an auroral oval. There are two of these on Earth, one in the Northern Hemisphere giving us the Aurora Borealis, and one in the Southern Hemisphere delivering the Aurora Australis. The rings represent the regions where the Earth's magnetic field passes down from space through the atmosphere towards the planet's geomagnetic poles.

The auroral ovals would be circular if left to their own devices, but the influence of the solar wind – charged particles and magnetic field lines heading out from the Sun – distorts the circle. The Sun-facing side of the oval gets displaced towards its geomagnetic pole while the anti-sunward or night side of the oval elongates away from the geomagnetic pole.

Oval activity

It's the section of the oval around the anti-sunward region which shows greatest activity and it's this part of the oval that extends furthest south. Both auroral ovals are essentially fixed in position relative to the Sun, but as the Earth turns on its rotational axis, so different areas pass under the active part of the oval and these are the locations which, on average, get to see most displays. The areas closest to the UK where this happens are to be found in northern Norway and Iceland. If the conditions are right, the ovals can expand, moving further away from the geomagnetic pole.

Cameras have a great advantage with the aurora. Their sensors are more sensitive than our eyes and can be made to 'look' at the aurora for extended periods. This causes faint auroral light to integrate into a signal that's easily strong enough to reveal colour.

This can only happen if the camera is held very still, on a tripod for example. As auroral detail is typically large scale, a mid- to wide-angle lens works best. As well as helping you catch more activity in frame, it'll also help reduce the blurring effects caused by movement of any auroral 'structures' which are present. A fast lens works well for this but beware that it's fairly common for a fully opened lens to introduce distortion at the edge of frame. If this happens – and it's most evident in star shapes – then close the lens by a stop or two.

High ISOs are great for freezing the action quickly and this too will help reduce the effects of motion blur within a rapidly moving aurora. The downside to high ISO is increased digital noise and less tonal range in the final result. As with many types of astrophotography, the best settings come down to compromise and judgement.

Whether you're photographing the aurora from a cold winter landscape near the Arctic Circle or trying to catch a chance display from the UK, chasing the Northern Lights can become very addictive. Just remember to actually look up from the camera from time to time to witness this amazing light show with your own eyes.

KEY TECHNIQUE

The screen on your camera is a very important tool. If you suspect an aurora is there, or just want to check, a high sensitivity exposure several seconds long should show you if there's any green present. If there is, this is a good sign that there's some form of auroral activity. It's important to constantly refer to the review screen during an auroral imaging session to make sure things are recording the way you want them to. It's easy to accidently knock a lens out of focus or miss a camera lens fogging over.

ALL PICTURES: PETE LAWRENCE

STEP BY STEP GUIDE

STEP 1

Make sure you have plenty of spare charged batteries and storage cards on hand. Cold conditions can deplete batteries fast. Other extras should ideally include a sturdy tripod (don't forget mounting plates if required) and a remote shutter cable. A mid- to wide-angle lens, say 50mm or shorter focal length, is highly recommended.

STEP 2

Set the lens to its lowest f/-number and take a 10s shot of the night sky at an ISO of 1600-3200. If stars appear badly distorted at the edge of the resulting image, consider closing the lens by a stop or two. Set the lens to manual focus, pre-focusing on a bright star. If your camera has Live View, use this at maximum magnification.

STEP 3

Fixing low-tack electrical tape on the focusing ring can help prevent accidental de-focusing once focused. Set the camera to manual mode and its ISO to a mid to high value of 800-3200. Mount on a stable tripod and point at the aurora. A tree or body of water in the frame may add another dimension to the shot. Make sure the camera is level.

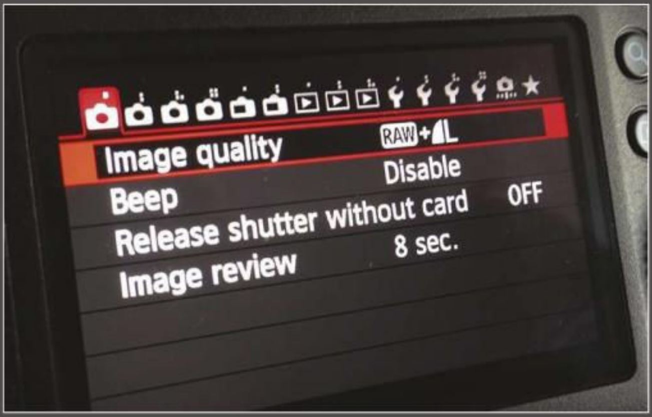
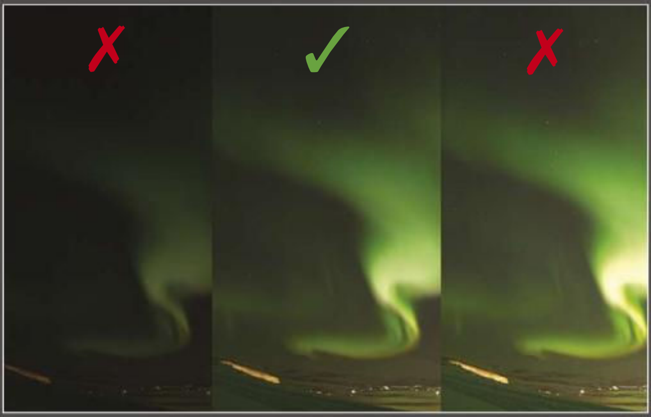


Image quality RAW+L
Beep Disable
Release shutter without card OFF
Image review 8 sec.

STEP 4

You'll get better results using your camera's RAW format so long as you have a way to open the files on your computer. The results will be cleaner and offer more flexibility for experimenting after capture. Using RAW and large JPEG gives you something immediate to play with if you're still looking for a way to handle RAWs.



STEP 5

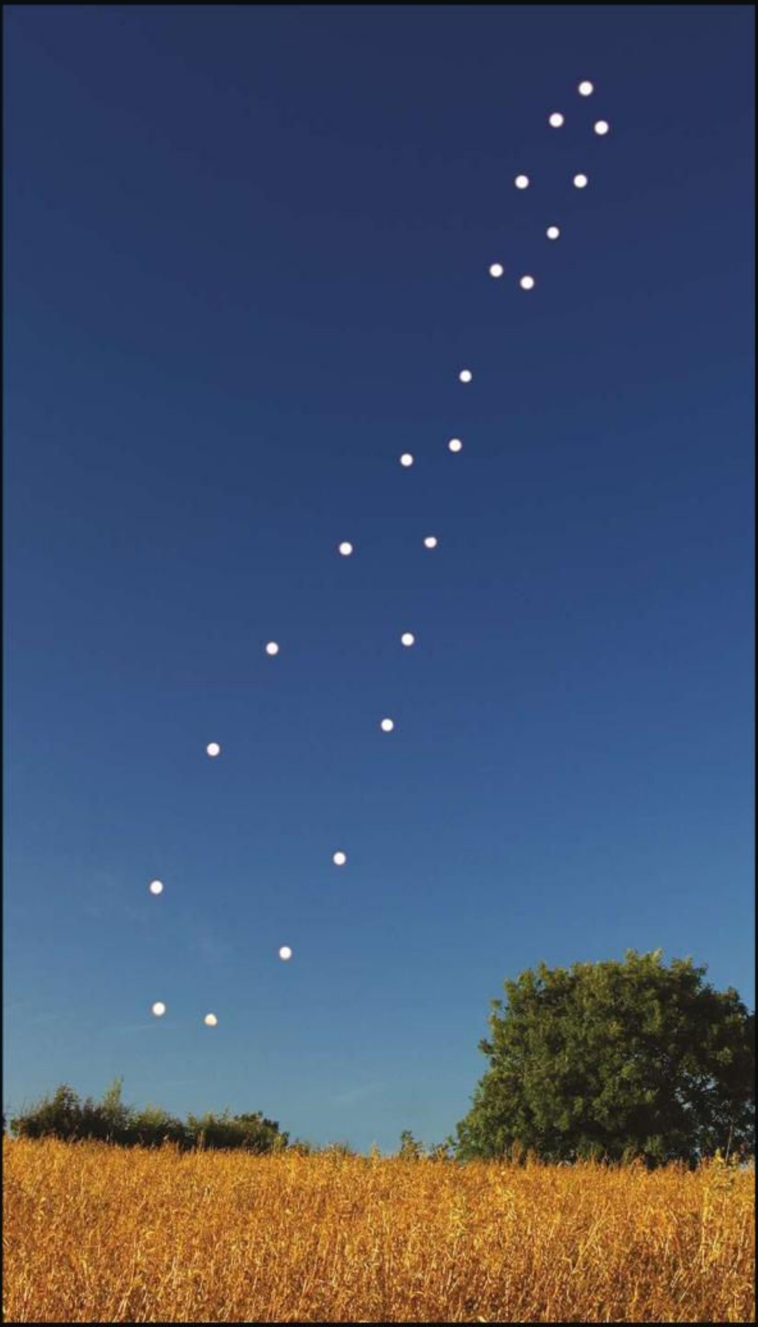
Use a remote shutter release cable to avoid unwanted camera shake when taking exposures. Do a test exposure of 10s and review. If any part of the aurora is over-exposed, try a shorter exposure. If the aurora appears dim, either raise the ISO or extend exposure. If very noisy, choose the longer exposure option over raising the ISO.

STEP 6

For a very active display, it's worth talking shots in quick succession. It'll then be possible to animate the results to show auroral movement. A programmable intervalometer can do this, or it's also possible by setting the shooting mode to continuous, setting exposure length and finally locking the remote shutter release button down so the camera keeps taking shots.

THE SUN

Accounting for 99.86 per cent of all the mass in the Solar System, observing the Sun requires special precautions. Never look at it with the naked eye or an unfiltered optical instrument, even a camera. Once you're viewing it safely, the visible surface of the Sun is a fascinating thing to observe, with its sunspots, bright plages and a texture like seething liquid fire. During a total eclipse, thanks to the cosmic coincidence of the Moon appearing exactly the same size as the solar disc, light shines through the lunar valleys producing the 'diamond ring' effect, while the blocking out of its light makes the prominences that rise from its rim more visible, especially in photographs.

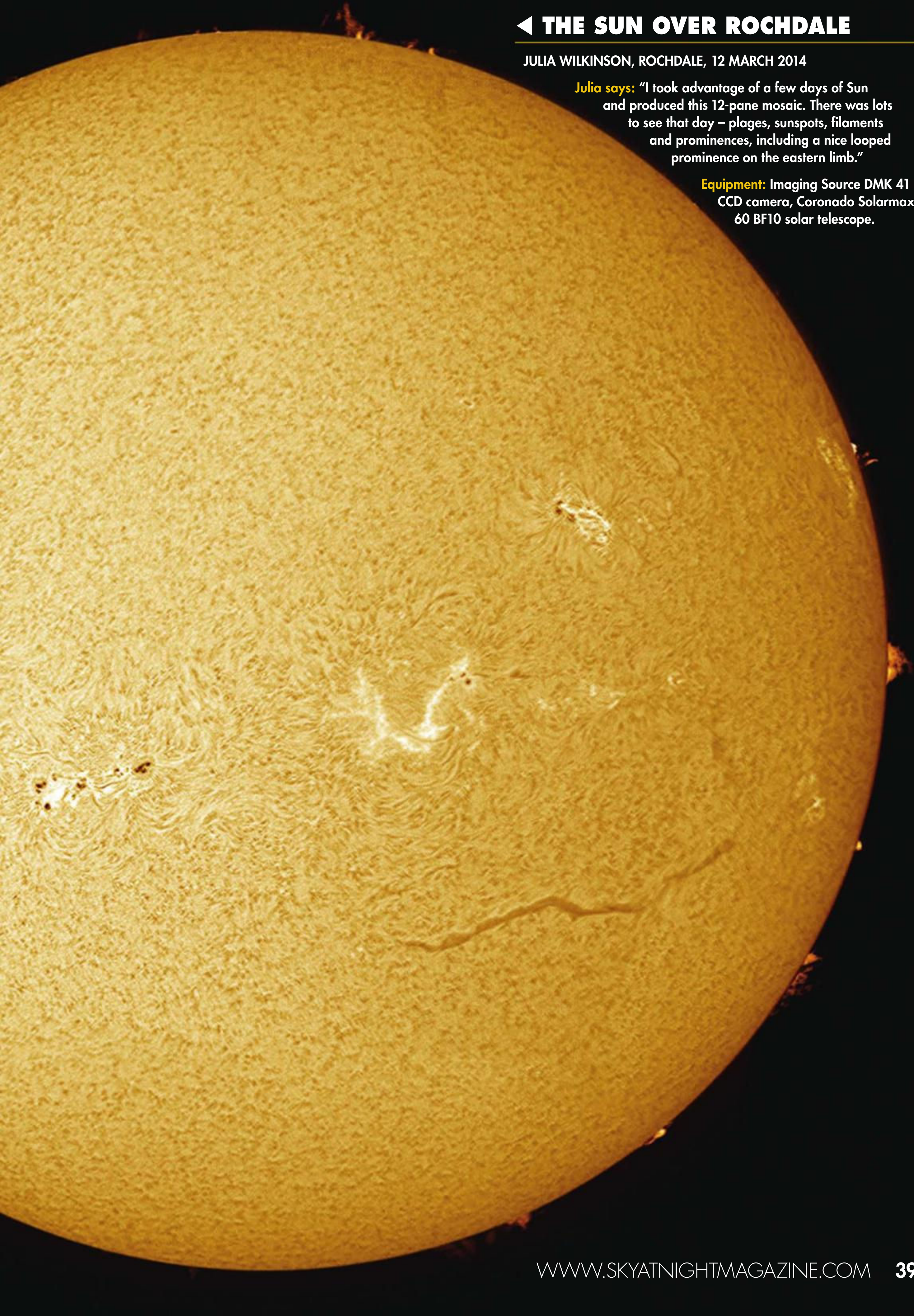


▲ A SOLAR ANALEMMA

JAMES COARD, LISBURN, COUNTY ANTRIM
21 SEPTEMBER 2006 – 8 SEPTEMBER 2007

James says: "I was at the mercy of the weather, and the poor summer meant that I missed the peak of the analemma around the solstice, but the pattern is still okay. My work schedule allows me to start early and finish early, but it was a struggle to get home in time on some sunny days to get the shot. Overall I'm pleased with the way it turned out, especially because it's my first attempt."

Equipment: Canon 400D DSLR camera, 18mm lens, Baader AstroSolar filter.

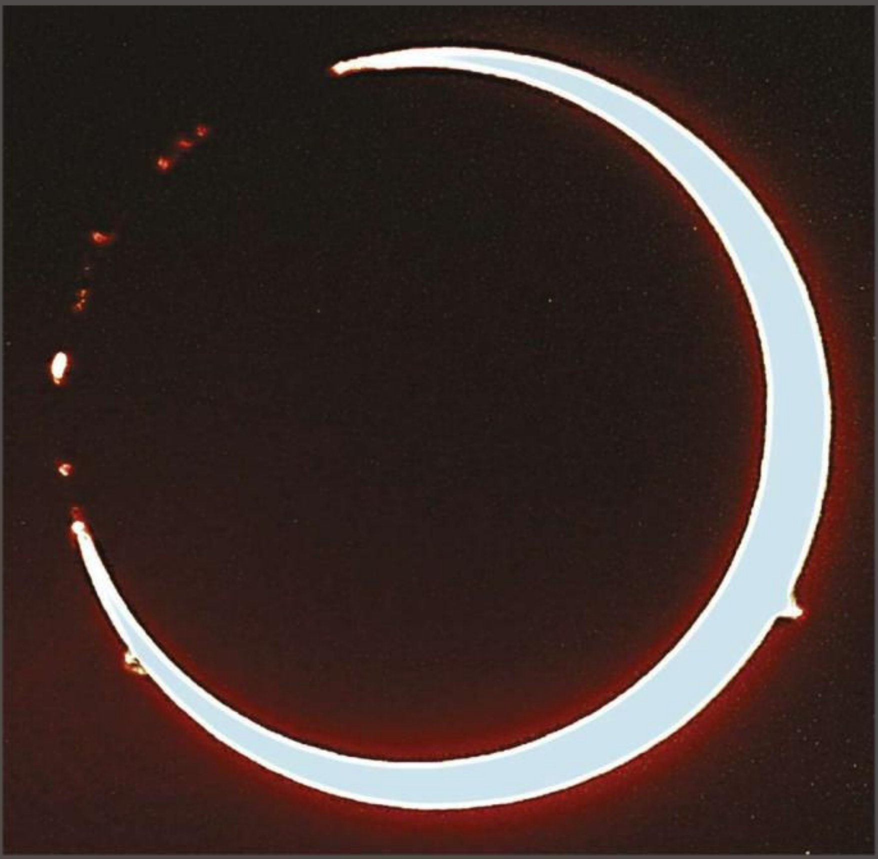


◀ THE SUN OVER ROCHDALE

JULIA WILKINSON, ROCHDALE, 12 MARCH 2014

Julia says: "I took advantage of a few days of Sun and produced this 12-pane mosaic. There was lots to see that day – plages, sunspots, filaments and prominences, including a nice looped prominence on the eastern limb."

Equipment: Imaging Source DMK 41 CCD camera, Coronado Solarmax 60 BF10 solar telescope.



◀ BAILY'S BEADS AND PROMINENCES DURING AN ECLIPSE

NICK HOWES, SEGOVIA, NORTHERN SPAIN, 3 OCTOBER 2005

Nick says: "The H-alpha light shows Baily's Beads – sunlight appearing between the Moon's valleys. The focus on this was not perfect, but it is a unusual image."

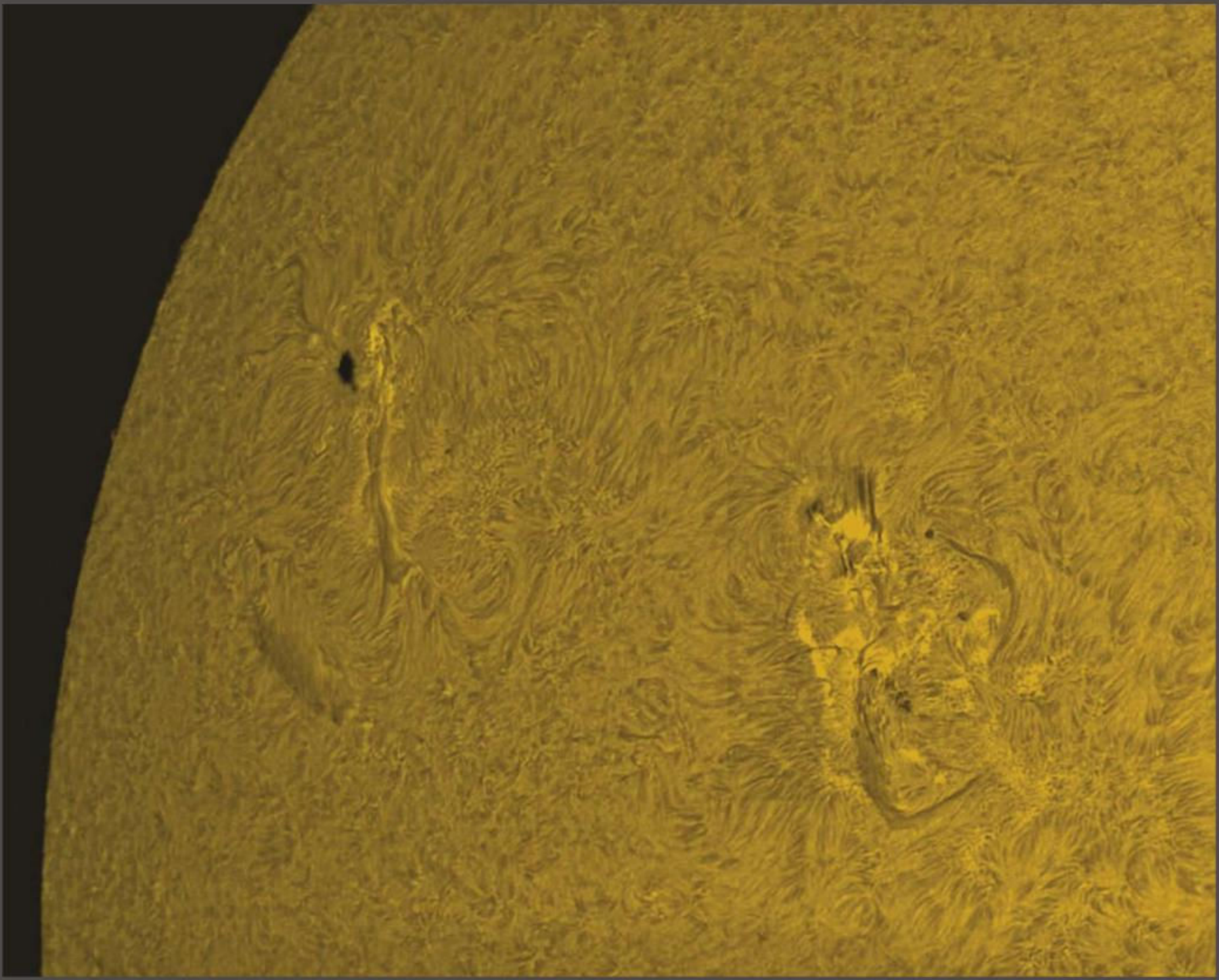
Equipment: Creative Labs digital camera, Solarscope 70.

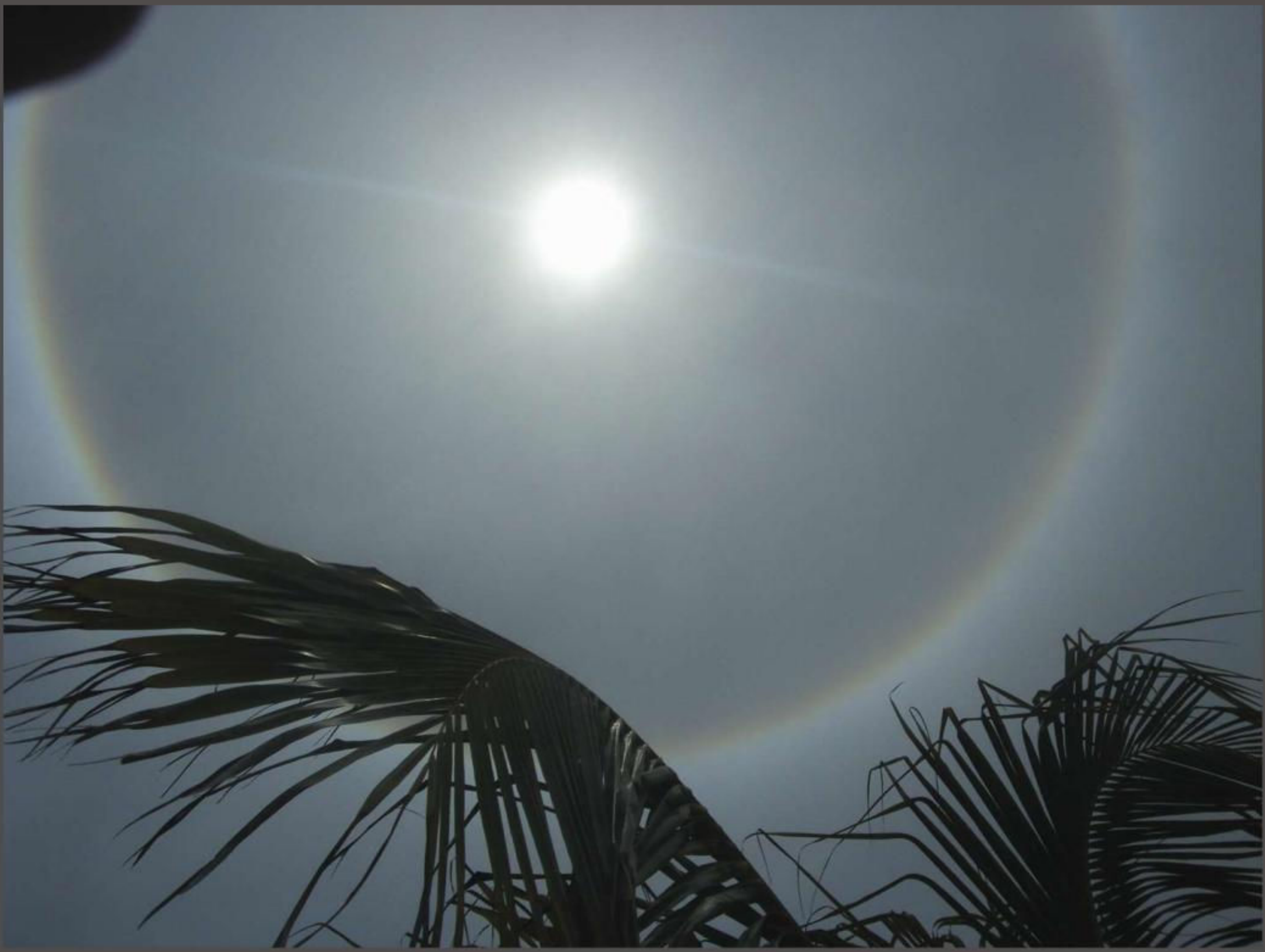
▼ THE SUN

GARY PALMER, WALES, 3 AUGUST 2011

Gary says: "This is one of my first images with the SolarMax II 90, and I'm amazed at the detail on the surface of the Sun from a solar telescope of this size."

Equipment: Opticstar CCD camera, SolarMax II 90 solar telescope.



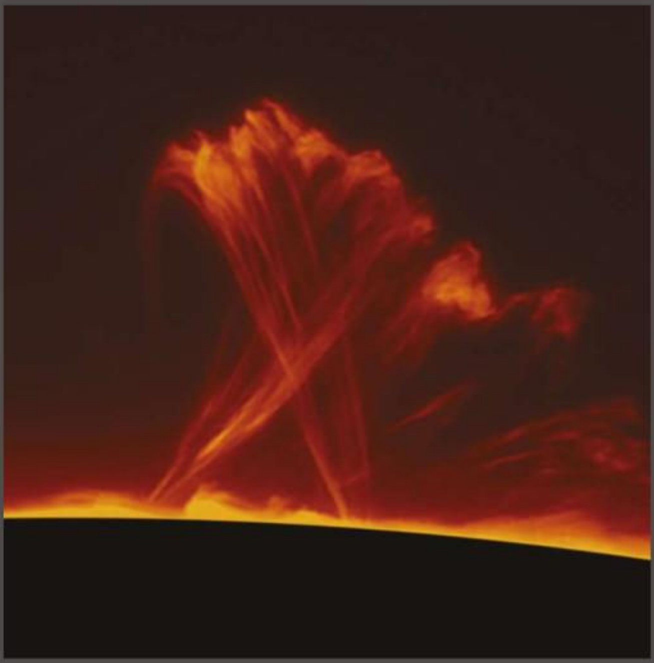


▲ SUN HALO

CHRIS STINSON, CANCUN, MEXICO, 27 APRIL 2008

Chris says: "My wife and I got married in Cancun, Mexico. Towards the end of the holiday the sky got a little cloudy. I was reading your excellent magazine when my mother-in-law told us to look at the sky. The Sun appeared to have a large, rainbow-like halo around it."

Equipment: Samsung i70 digital camera.

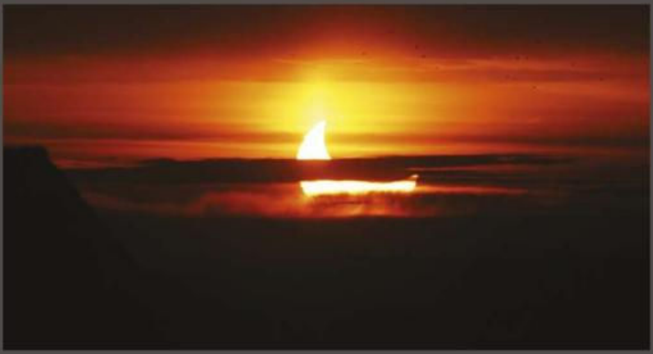


▼ PARTIAL ECLIPSE SUNRISE

BAS VAN BEEK, WERKHOVEN, THE NETHERLANDS, 4 JANUARY 2011

Bas says: "When I woke up that morning I was sure that I would not see anything of this eclipse. But when my wife looked out of the window at the time the Sun was rising, she saw a very red coloured sky and immediately called me. I rushed up to the attic and could see the Sun partially eclipsed."

Equipment: Canon EOS 350D DSLR camera.



◀ LOOP PROMINENCE

PAOLO PORCELLANA, ASTI, ITALY, 31 DECEMBER 2013

Paulo says: "This loop prominence was created after a few flares on New Year's Eve. The multi-crossed loop showed up for several minutes; the solar disc was masked to make it easier to see the details."

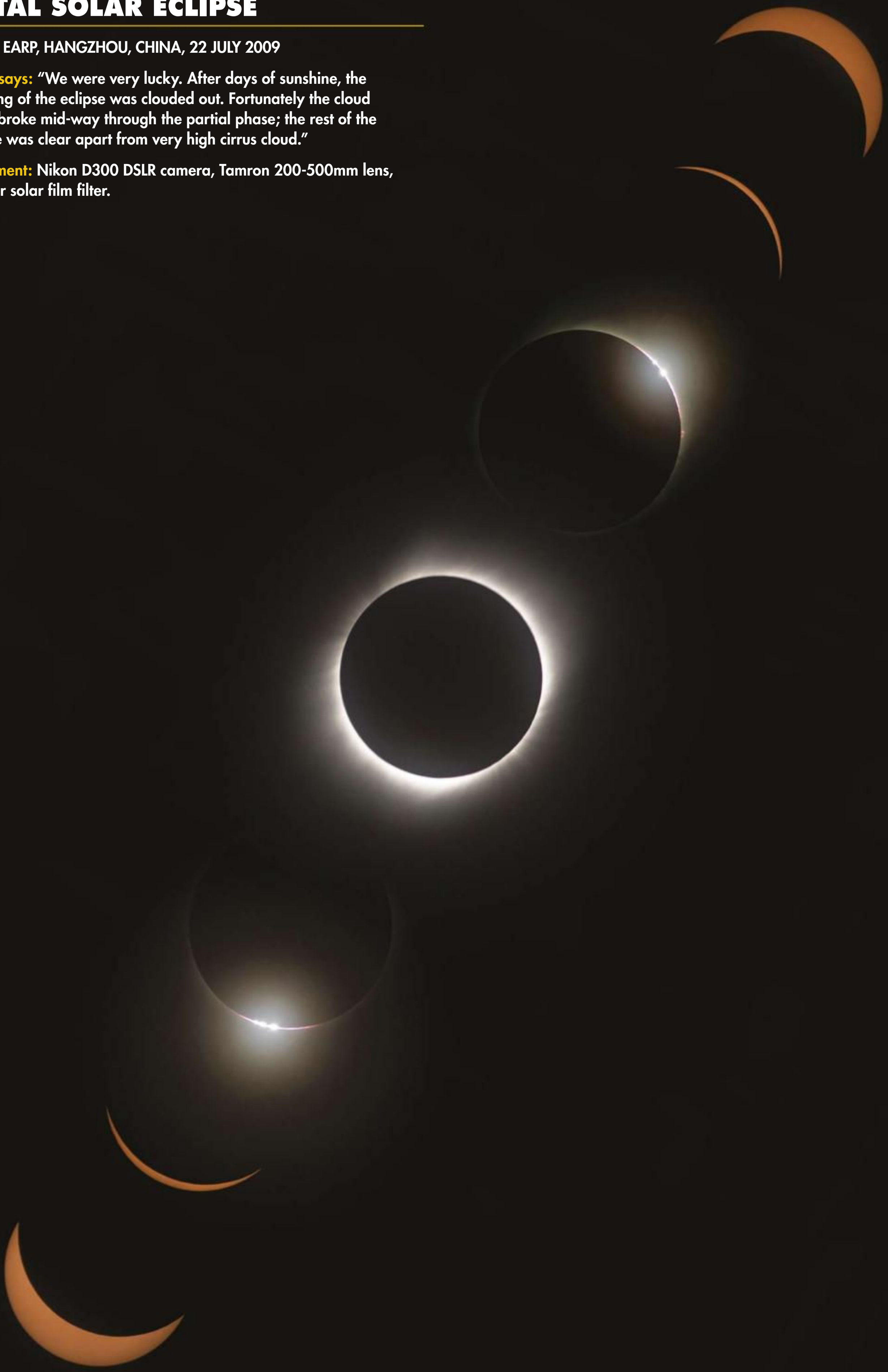
Equipment: Canon EOS 650D DSLR camera.

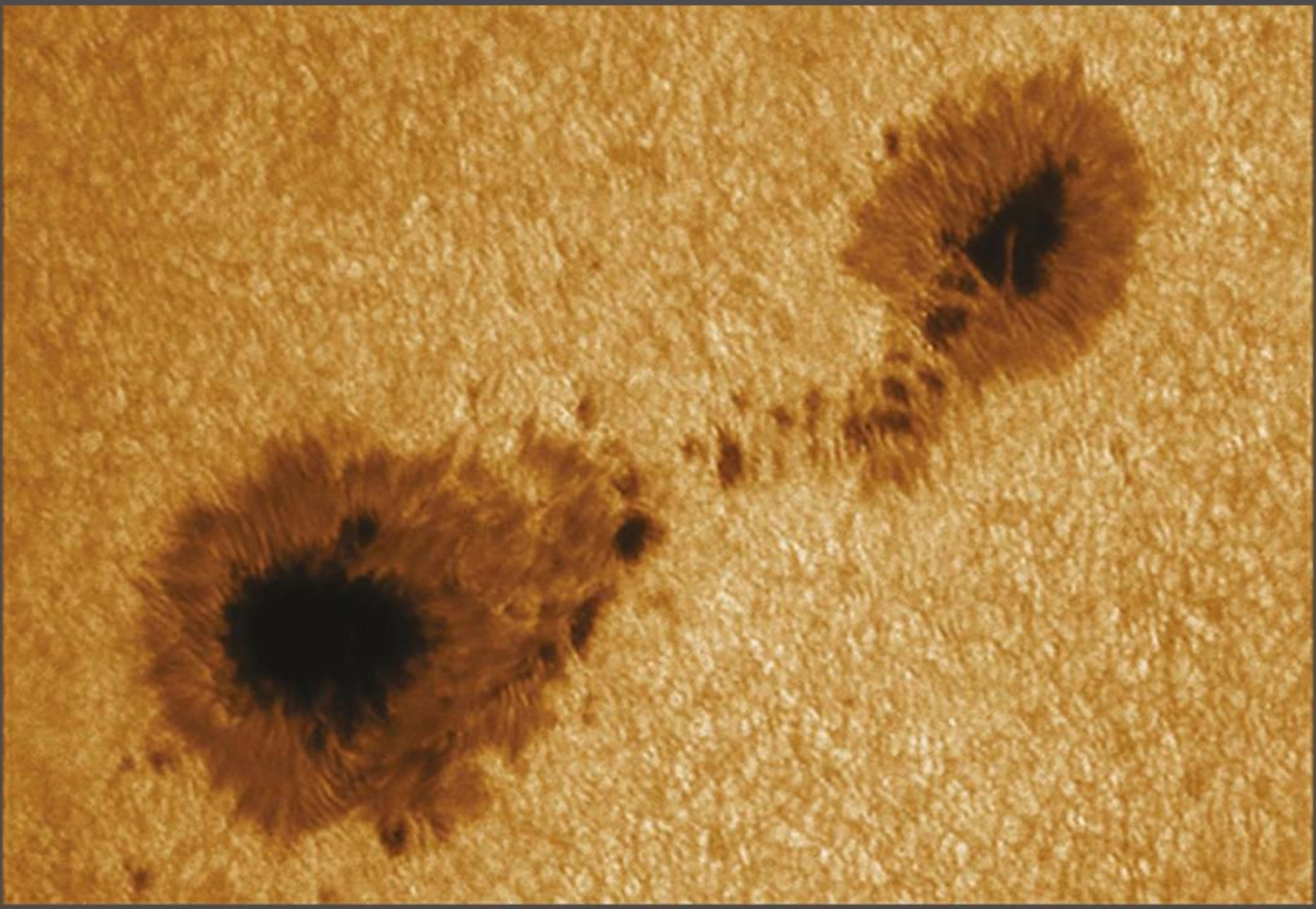
TOTAL SOLAR ECLIPSE

KEVIN EARP, HANGZHOU, CHINA, 22 JULY 2009

Kevin says: "We were very lucky. After days of sunshine, the morning of the eclipse was clouded out. Fortunately the cloud cover broke mid-way through the partial phase; the rest of the eclipse was clear apart from very high cirrus cloud."

Equipment: Nikon D300 DSLR camera, Tamron 200-500mm lens, Baader solar film filter.





▲ SOLAR ACTIVE REGION 1057

PAUL ROBERTSON, STAFFORDSHIRE, 27 MARCH 2010

Paul says: "The Sun was spotless for 71 per cent of 2009, but just 7 per cent of 2010's days played host to a spotless Sun. It's always worthwhile imaging the Sun in white light. This was the large sunspot group associated with active region 1057."

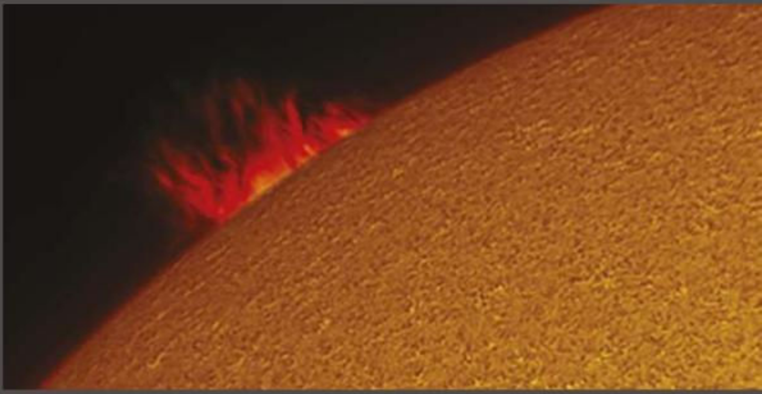
Equipment: Imaging Source DMK CCD camera, Celestron C9.25 Schmidt-Cassegrain telescope, Baader AstroSolar safety film, 2x Barlow lens, green filter.

▲ SLOVAKIAN SUNSET

OTTÓ MÉHES, SAMORIN, SLOVAKIA, 6 OCTOBER 2006

Ottó says: "I was sitting on the beach of the dam channel near my home town waiting for the right moment to start taking photos. This sunset surprised me as the Austrian mountain eclipsing the Sun was not visible until it began to obscure the solar disc."

Equipment: Canon 350D DSLR camera, Canon 75–300mm lens.



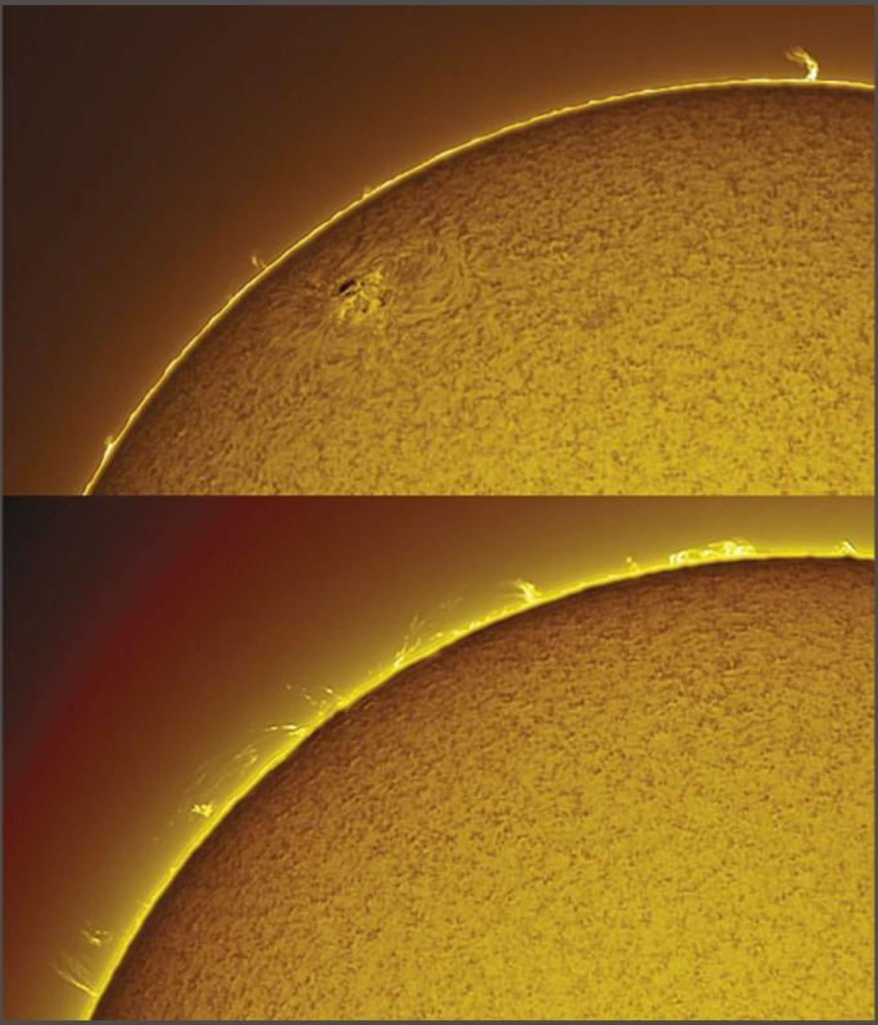
▲ SOLAR PROMINENCE

PHILIP REED, HAMPSHIRE, 13 MARCH 2011

Philip says: "Without the Sun there would be no life on this planet, but it is also violent. This prominence is many times the size of the Earth and shows how small we are."

Equipment: Imaging Source DMK 21AU04.AS CCD camera, Coronado SolarMax II 60 BF15 solar telescope.

THE SUN



◀ THE SUN'S LIMB

ALAN CLITHEROW, FIFE, SCOTLAND, 29 & 31 OCTOBER 2009

Alan says: "This image reveals two days in the life of a solar active region (AR11029). The upper frame clearly shows the region approaching the northwest limb of the Sun, as well as some unrelated small prominence. The lower frame shows the prominence activity associated with the spot and active region."

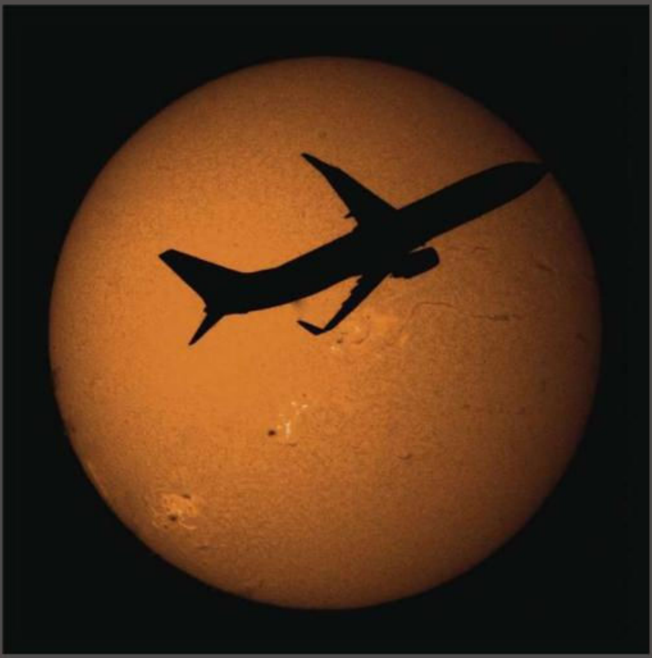
Equipment: Philips SPC900NC webcam, Sky-Watcher ED80 refractor, Lunt LS50 H-alpha etalon and matching blocking filter.

▼ THE SUN AT MIDNIGHT

ARNAUD DEBAIZE, NORTH CAP, NORWAY, 18 JULY 2006

Arnaud says: "The Sun had not shone for 10 days, but that night the winds were blowing so strong that the Sun appeared at 11pm. At midnight, it was still there, shining brilliantly. It was a wonderful moment!"

Equipment: Nikon F55 SLR camera, Nikon 28-80mm lens.



▲ THE SUN AND A PLANE

PATRICK POITEVIN, DERBYSHIRE, 16 FEBRUARY 2014

Patrick says: "The weather in the UK was really bad, so this was the first time I managed to image the Sun that year. My Lunt 35 and DMK 41 were having withdrawal symptoms!"

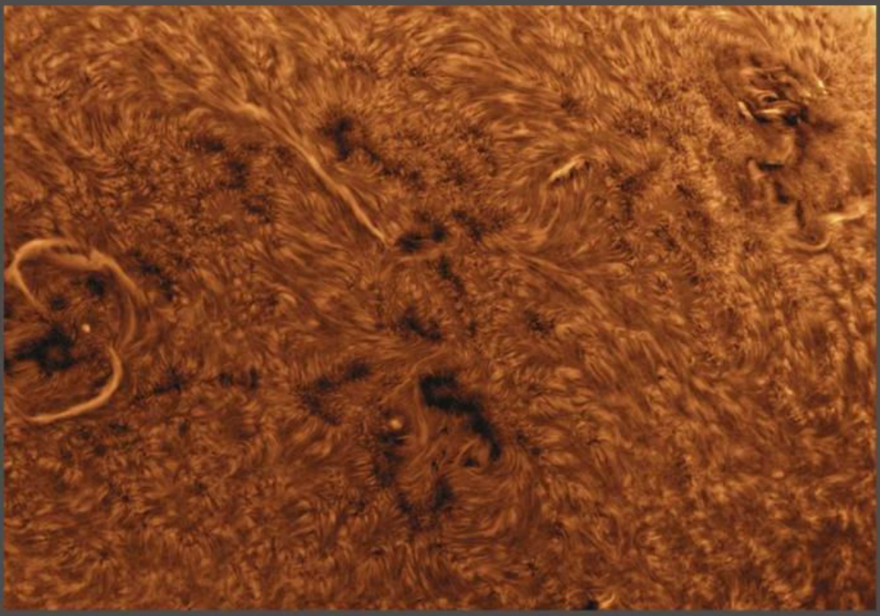
Equipment: DMK 41 CCD camera, Lunt 35 solar telescope.

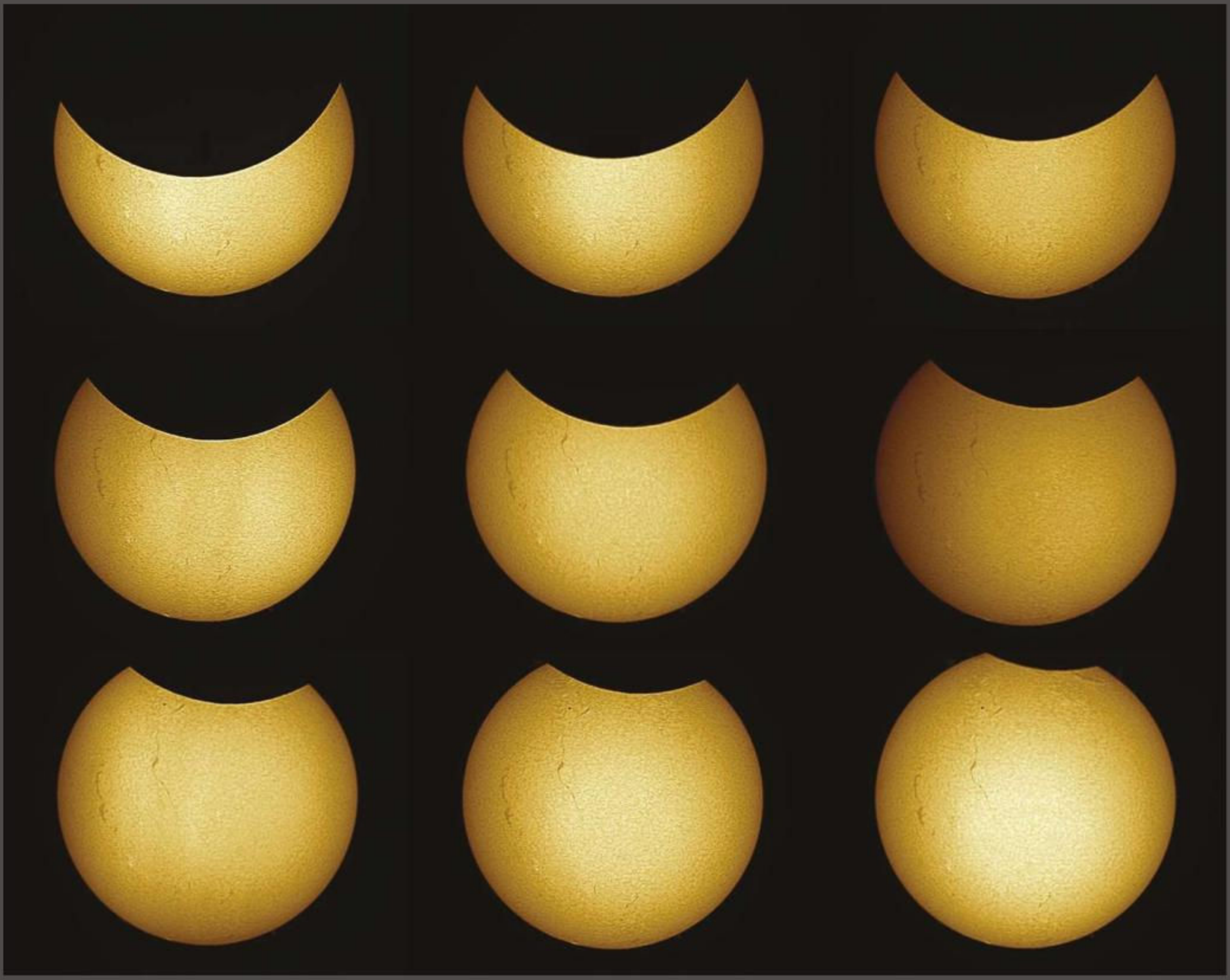
SOLAR ACTIVE REGIONS ▶

IVAR KOOREN, HEENVLIET, THE NETHERLANDS, 12 JUNE 2015

Ivar says: "What I always like about the Sun is that it is so dynamic. Every week, every day and even every minute it is changing. Because of a lousy summer, I have been on the lookout for gaps between the clouds to shoot some pictures of the most active regions of our star."

Equipment used: ZWO ASI174 monochrome CMOS camera, 4-inch modded PST.





▲ PARTIAL ECLIPSE SEQUENCE

MARK GRIFFITH, SWINDON, 20 MARCH 2015

Mark says: "This picture is a collage of nine images with five-minute intervals between them. There was thick cloud to start with and it looked as though I was not going to be able to capture any images; fortunately they started to thin. Light cloud remained for the rest of the eclipse, but with the Sun being so bright I was still able to capture some detail."

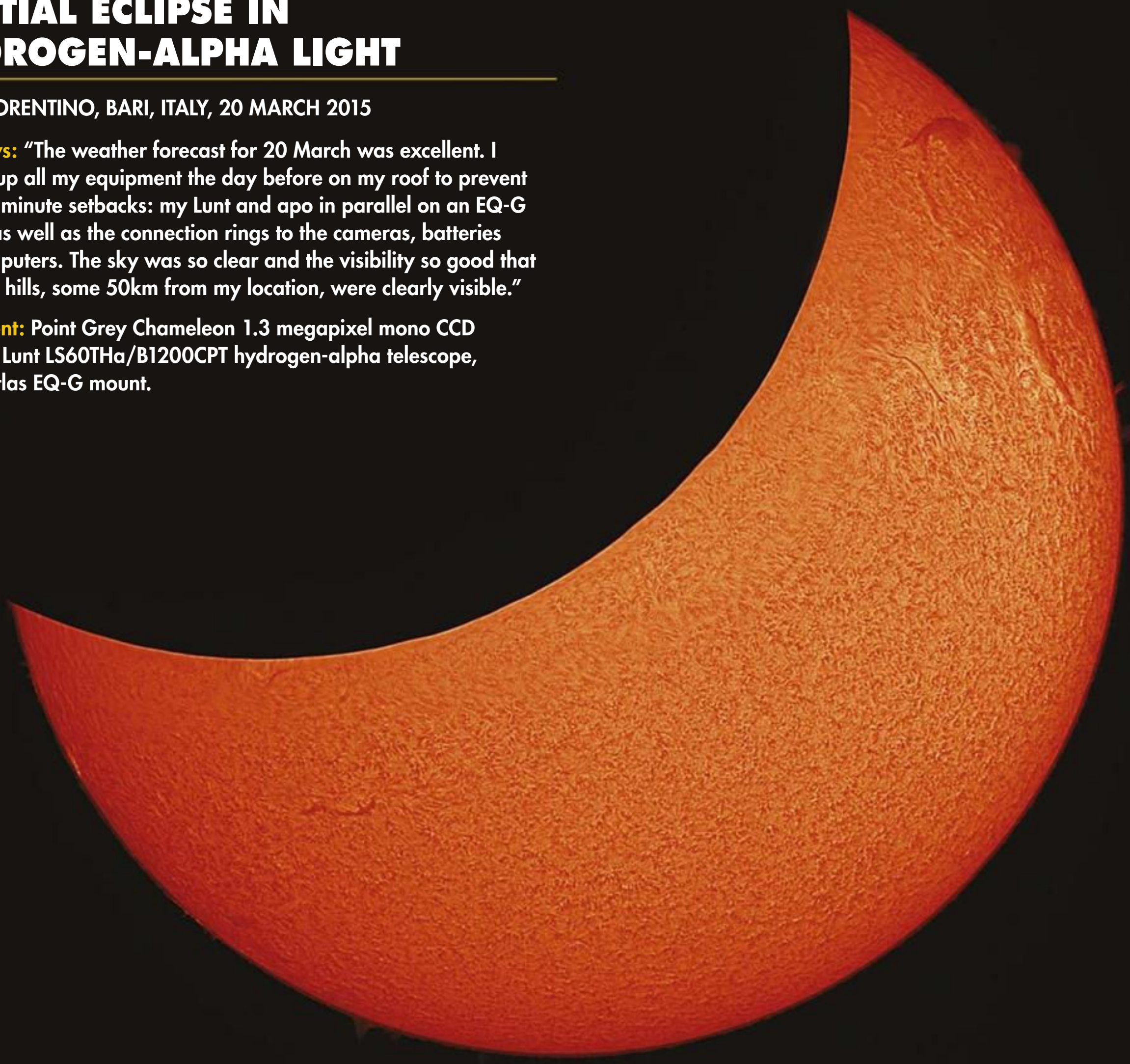
Equipment: Imaging Source DMK 41 monochrome CCD camera, Lunt 35mm hydrogen-alpha telescope, Sky-Watcher NEQ6 Pro mount.

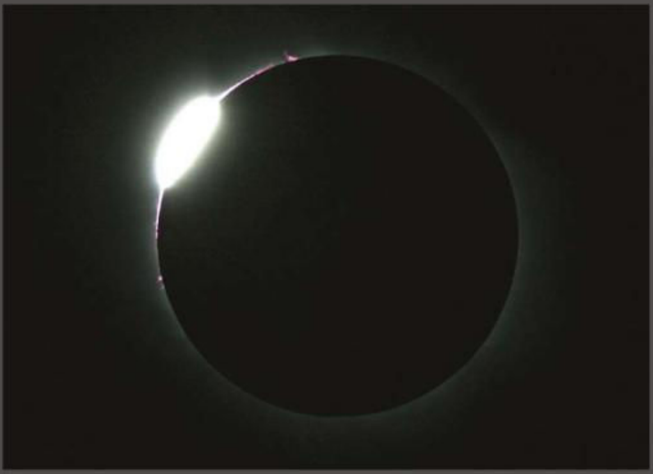
PARTIAL ECLIPSE IN HYDROGEN-ALPHA LIGHT

LUIGI FIORENTINO, BARI, ITALY, 20 MARCH 2015

Luigi says: "The weather forecast for 20 March was excellent. I had set up all my equipment the day before on my roof to prevent any last-minute setbacks: my Lunt and apo in parallel on an EQ-G mount, as well as the connection rings to the cameras, batteries and computers. The sky was so clear and the visibility so good that even the hills, some 50km from my location, were clearly visible."

Equipment: Point Grey Chameleon 1.3 megapixel mono CCD camera, Lunt LS60THa/B1200CPT hydrogen-alpha telescope, Orion Atlas EQ-G mount.





▲ THE DIAMOND RING EFFECT

BRUCE KINGSLEY, SIDE, TURKEY 29 MARCH 2006

Bruce says: This image was difficult to obtain with the equipment I was using and with such little time in which to take it."

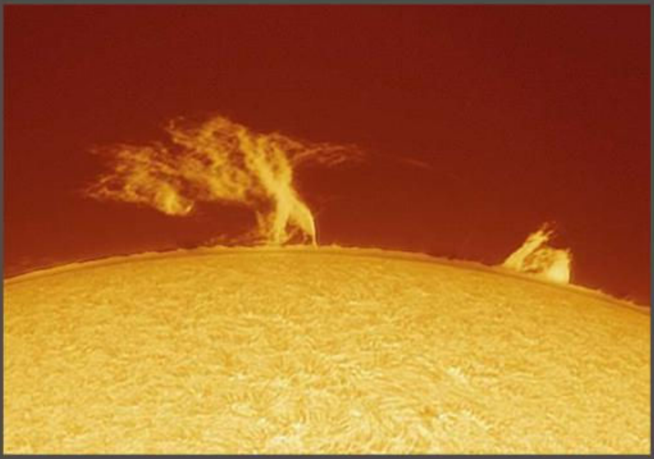
Equipment: Canon EOS 350D DSLR camera, 1,000mm f/10 lens.

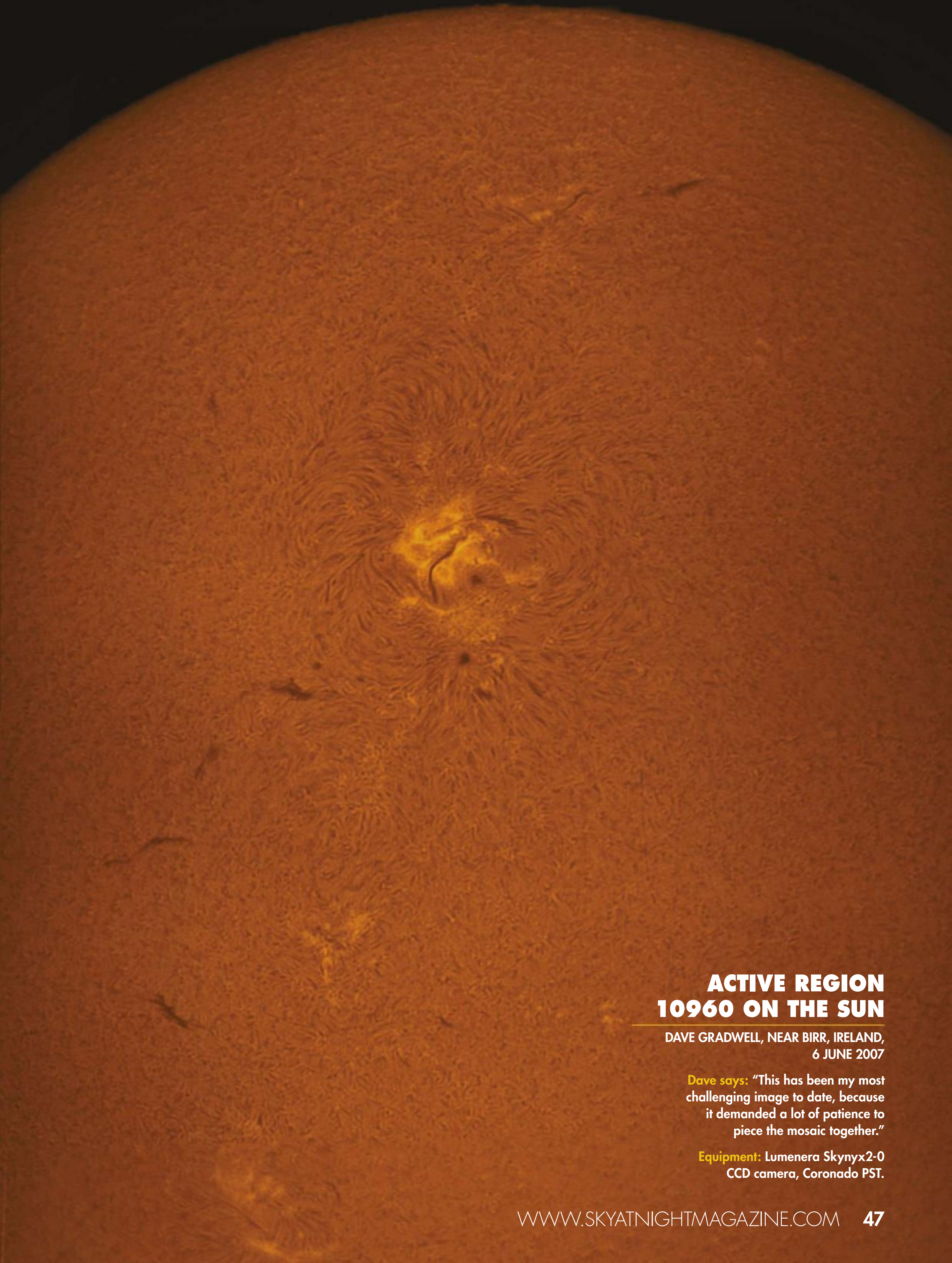
▼ SOLAR PROMINENCE

ANDRÉ VAN DER HOEVEN, THE NETHERLANDS, 30 JUNE 2012

André says: "On 30 June, while I watched there was a beautiful prominence, resembling a man throwing fire at a snail. I tried to capture the moment and was astonished by the beauty of solar prominences."

Equipment: Imaging Source DMK 21AU618.AS CCD camera, Lunt 60 BF1200 solar telescope, NEQ6 mount.



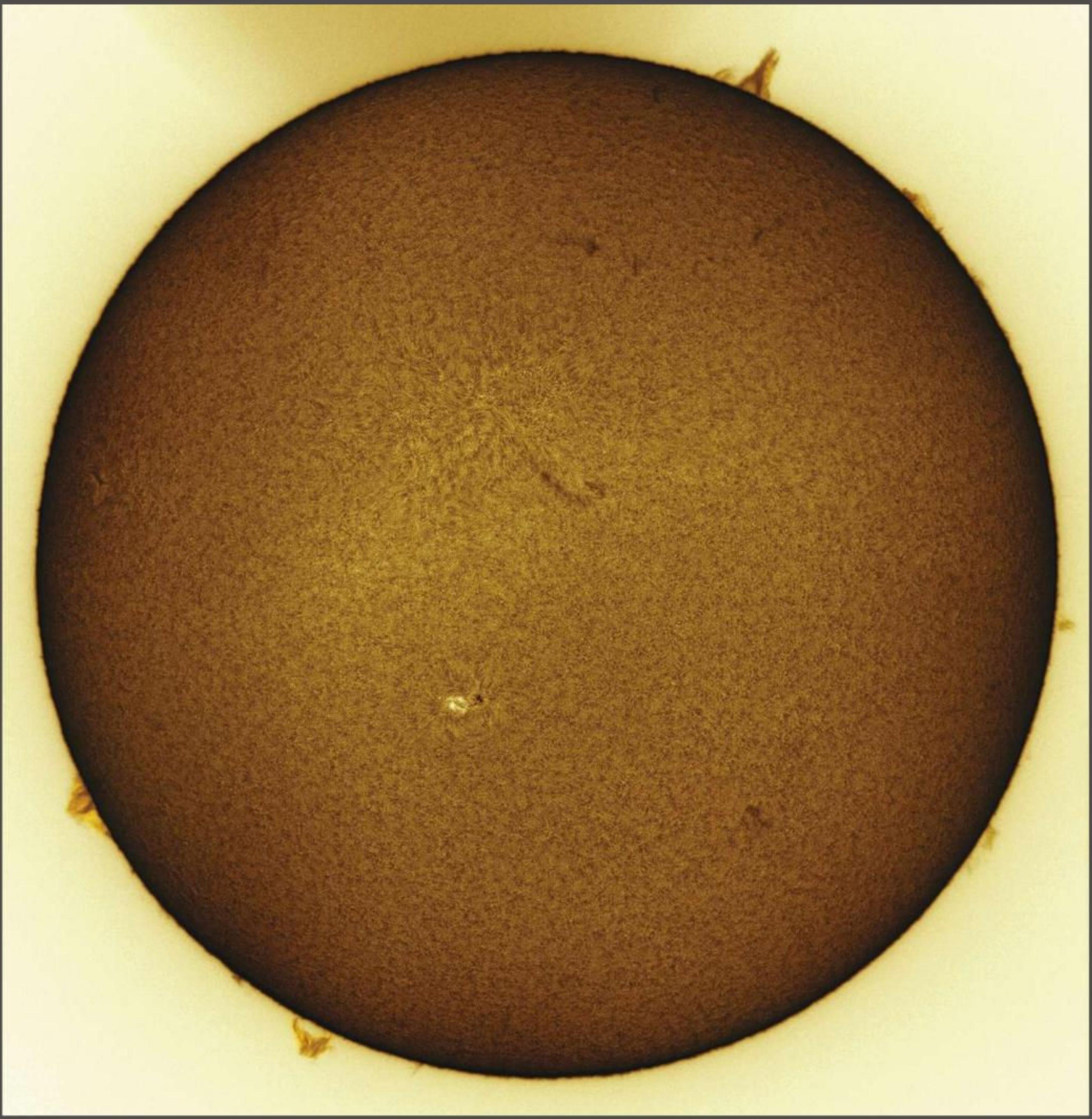


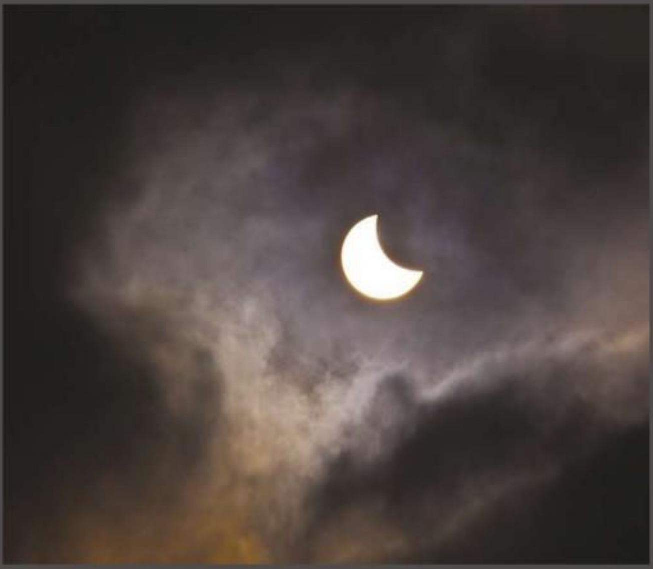
ACTIVE REGION 10960 ON THE SUN

DAVE GRADWELL, NEAR BIRR, IRELAND,
6 JUNE 2007

Dave says: "This has been my most challenging image to date, because it demanded a lot of patience to piece the mosaic together."

Equipment: Lumenera Skynyx2-0 CCD camera, Coronado PST.





▲ THE SUN OVER SWEDEN

PER-MAGNUS HEDÉN, VALLENTUNA, SWEDEN, 22 MAY 2010

Per-Magnus says: "The picture is made from two photos, one for the top and the other for the bottom. I had great seeing and was able to take clear shots of the disc with some filaments, sunspots and prominences."

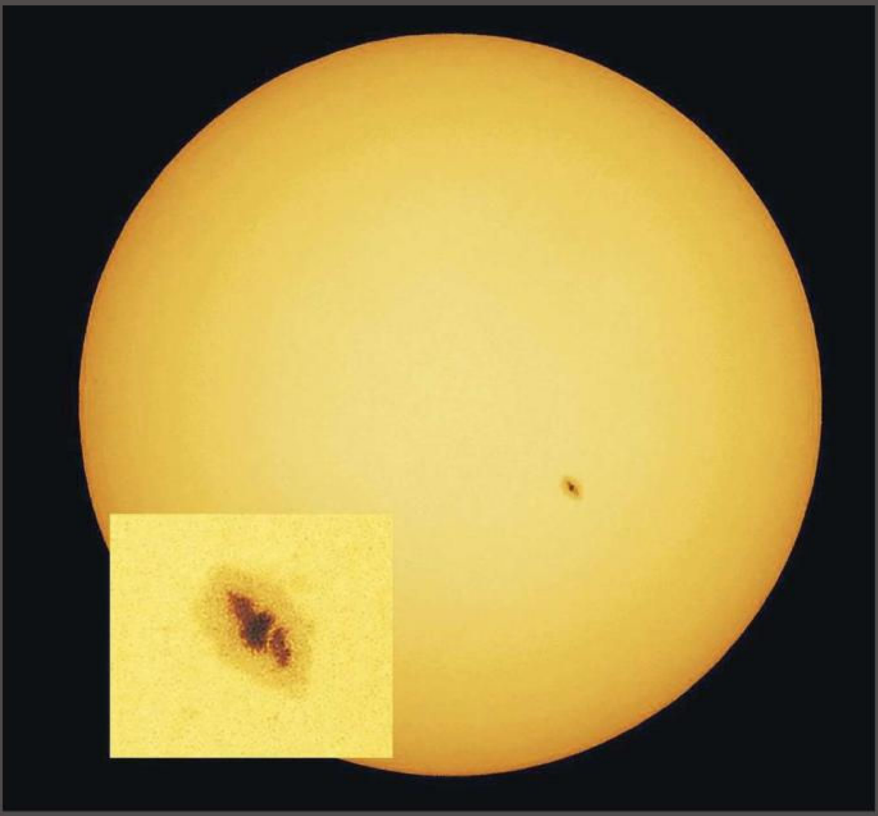
Equipment: Modified Canon EOS 350D DSLR camera, Orion 100ED 100mm refractor, SolarMax 60 solar filter.

◀ ECLIPSE THROUGH THE CLOUDS

DAVID DE CUEVEAS, BRITTANY, FRANCE, 20 MARCH 2015

David says: "It was a fantastic journey to shoot the eclipse in France. It was raining almost everywhere. I left very early in the morning to travel the three and a half hour trip along the coast in Brittany."

Equipment: Canon EOS 450D DSLR camera, Canon 70-200mm lens.



◀ SUNSPOT 898

PETER PAICE, BELFAST, 5 JULY 2006

Peter says: "After several days of very hot weather and thick haze it was pleasing to have a bright morning with good seeing at last. The roughness of the inset image is due to the 200ASA setting that was needed when the camera was at maximum zoom, compared to 64ASA for the disc image."

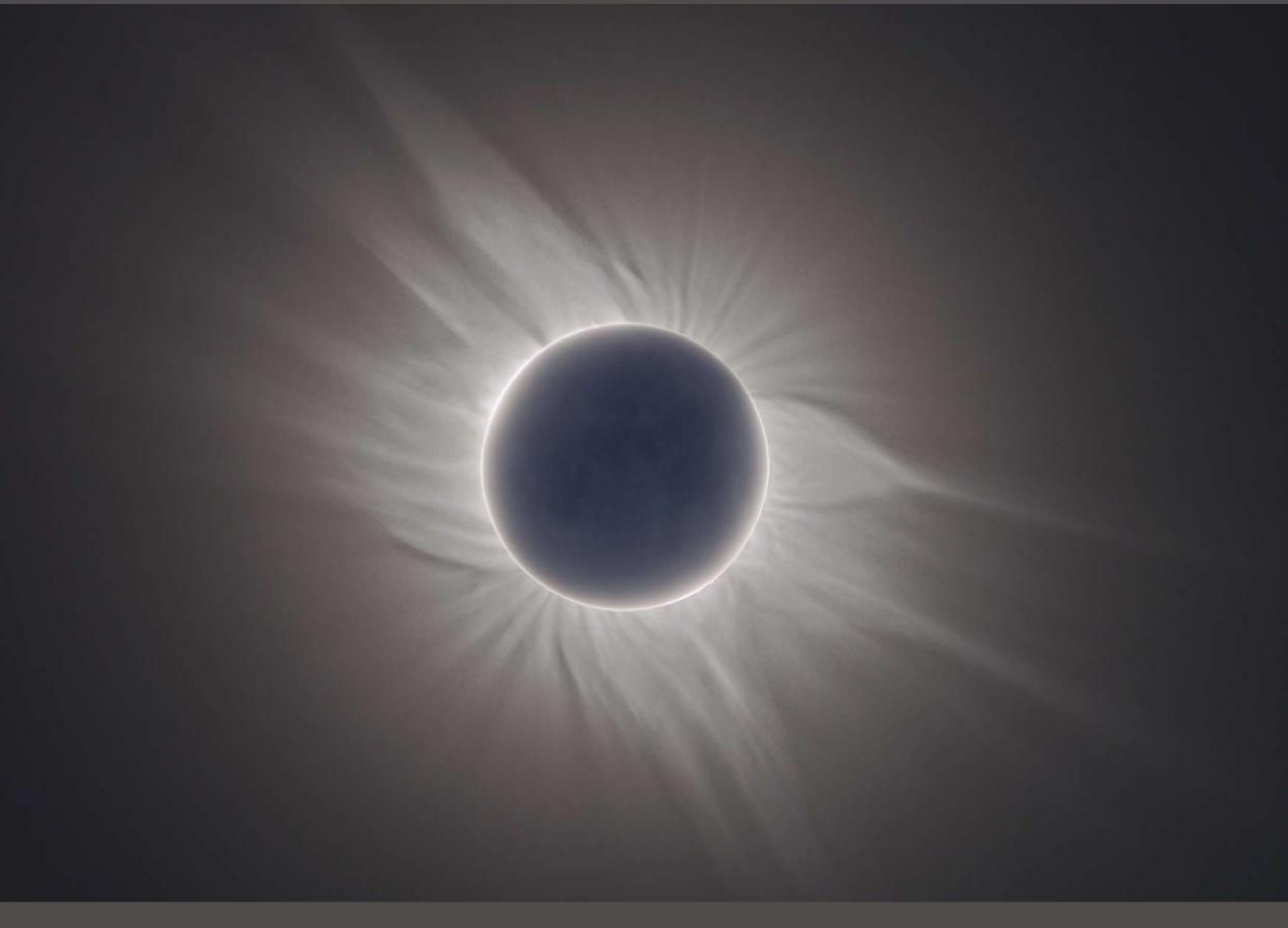
Equipment: Olympus 5050Z digital camera, 6-inch refractor, Baader AstroSolar film.

▼ EARTHSHINE DURING TOTALITY

NICK KING, SIDE, TURKEY, 29 MARCH 2006

Nick says: "This image was taken during a BBC Sky at Night eclipse trip. We had a great time out there, witnessed an awesome event and met some really lovely people."

Equipment: Canon EOS 300D DSLR camera, 100–400mm lens with 2x extender.



ASTROPHOTOGRAPHY TUTORIAL

WORDS: PETE LAWRENCE

THE SUN'S ROTATION

RECOMMENDED EQUIPMENT

Telescope on driven equatorial mount, white light filter, high frame rate camera. For monochrome cameras a green or solar continuum filter can help to reveal solar granulation

Assuming the clouds are being kind, there are many ways to observe the Sun safely, and the simplest employs what's known as a white light filter.

The solar features most commonly seen through white light filters are sunspots. These are cooler patches where concentrations of magnetic field lines poke through the Sun's visible surface, and highlight the Sun's rotation.

White light filters can be used with any telescope so long as they cover the main aperture fully. Making one for yourself is pretty straightforward – find out how in a video at www.bbc.co.uk/programmes/p014hpkh. You can buy one ready made, too.

We're aiming to create a solar mosaic at a scale that will show sunspot groups with a reasonable definition. However, there is no reason why you can't do this with a single image, so long as you have the right setup – for instance, a DSLR attached to a telescope with a focal length of 1.2m or less.

The layer of the Sun you can see through a white light filter is known as the photosphere. It may, initially, appear featureless. Stick with it and you'll notice shading towards the edge – a phenomenon known as limb darkening.

Granularity revealed

A 3-inch scope or larger should also be able to reveal solar granulation, the rice-grain texture of the photosphere. This pattern represents the tops of huge internal convective cells, welling up to the Sun's surface. Looking closely at the solar granulation pattern reveals subtle markings. These are useful when you're attempting to put together a mosaic.

Although sunspots do change shape, you'll typically have to wait for several hours to see it. Faster changes are fairly rare. Over several days, a larger group of sunspots may show plenty of internal changes, but will typically retain a recognisable form.

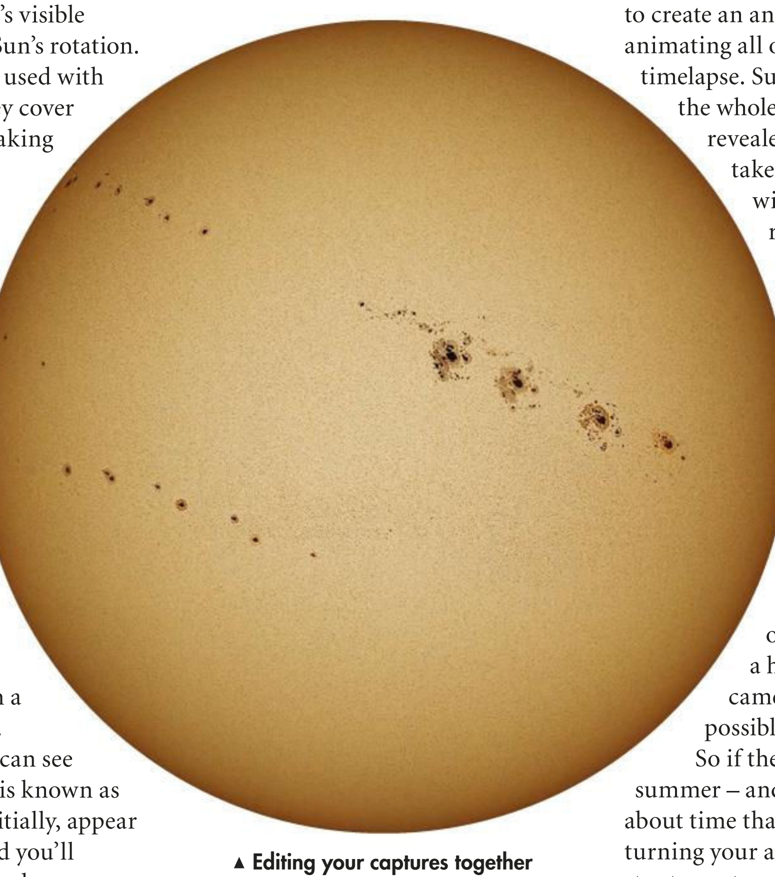
Sunspot changes are easily revealed by a camera. Use a DSLR – or high frame rate planetary camera – attached to a night-time telescope fitted with a solar filter. Add a Barlow lens to increase its effective focal length to give you a focal ratio of between f/15 and f/40.

It is easy to calculate the focal ratio you'll get by adding a Barlow: just multiply the focal ratio of the scope by the magnification of the Barlow. The focal ratio is the scope's natural focal length divided by the size of its aperture using the same units. So if you fit an f/9 scope with a 2x Barlow, your telescope will end up with a focal ratio of f/18. If the seeing is poor, keep the focal ratio towards the lower end of the range.

Capture a number of image sequences and process them using your preferred registration and stacking program. Load the images into a layer-based graphics editor and align similar features in each image between the layers. Flicking between layers, it is obvious that there is some movement going on, even if it is very subtle. If your software allows you to create an animated GIF, try animating all of the layers to create a timelapse. Sunspot movement across the whole of the Sun can be revealed by comparing images taken over several days. This will reveal how the Sun rotates over time.

How much of the solar disc you can capture in one image depends on your setup. If, as is likely, you can't get it all on in one go, you'll need to capture it in sections, leaving a good overlap between each frame – use the technique described in the step-by-step guide opposite. In this, I'm using a high frame rate planetary camera to give the sharpest possible results.

So if the UK has a reasonable summer – and let's be honest, it's about time that happened – consider turning your attention to our nearest star to capture some stunning images of its disc.



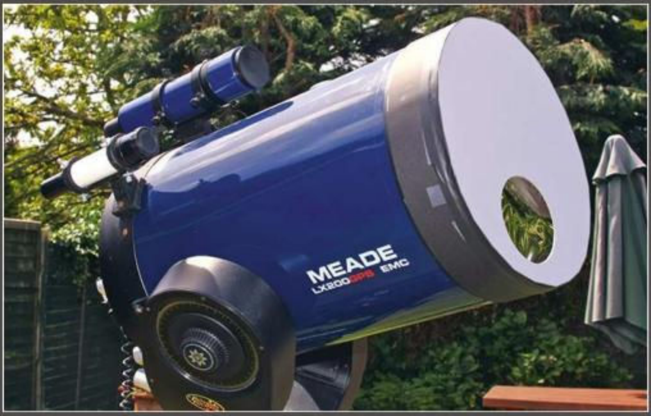
▲ Editing your captures together will allow you to see how sunspots journey across the solar disc

ALL PICTURES: PETE LAWRENCE

KEY TECHNIQUE

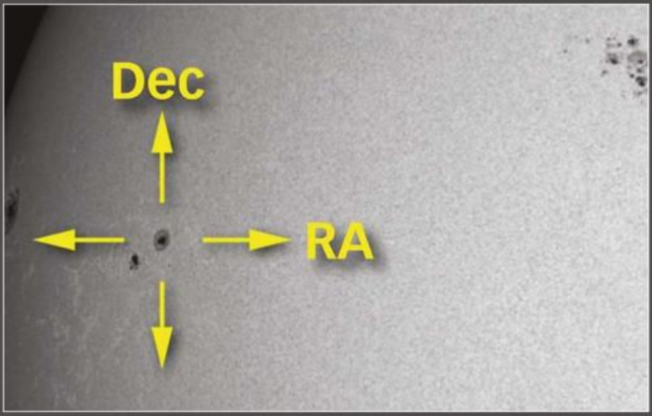
A vitally important aspect of solar imaging is keeping the Sun's orientation consistent from one day to the next. This is key to showing the Sun's rotation. It's simple to do using an equatorial mount, but if you are using an altazimuth mount, such as a basic tripod, freeware program Tilting Sun (www.atoptics.co.uk/tiltsun.htm) can help you work out how the Sun's disc is orientated at a specific time and date. It is good practice to mark the date and time of capture (along with the orientation) on the final image.

STEP BY STEP GUIDE



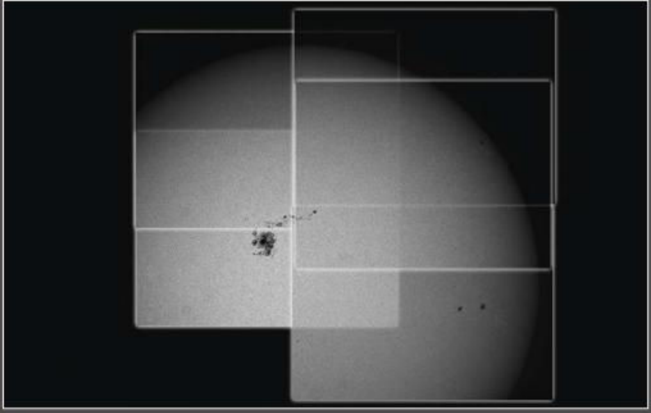
STEP 1

Before pointing your setup at the Sun, check and fit your white light filter and remove or cap any finderscopes. Locate the Sun using the camera and focus on a sunspot or the limb. Centre on the middle of the solar disc and check for overexposure – there should be no white visible. The Levels meter should read just less than maximum.



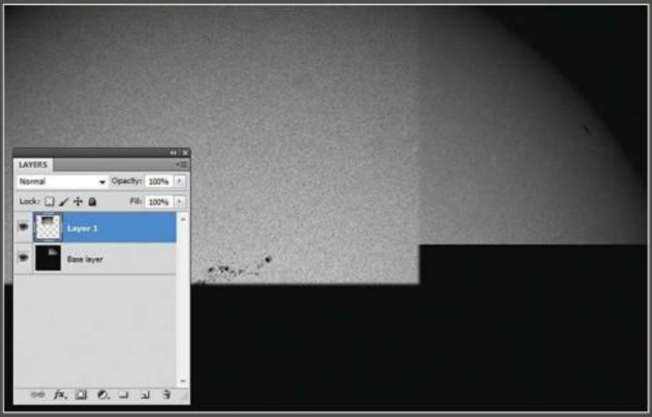
STEP 2

Move the telescope in RA. Orientate the camera so that features on the Sun move parallel to the bottom of the image frame. Push the front of the scope up. Note the direction – the leading edge of the Sun is the northern limb. Apply pressure to the front of the scope to push it to the west; the leading edge of the Sun is the western limb.



STEP 3

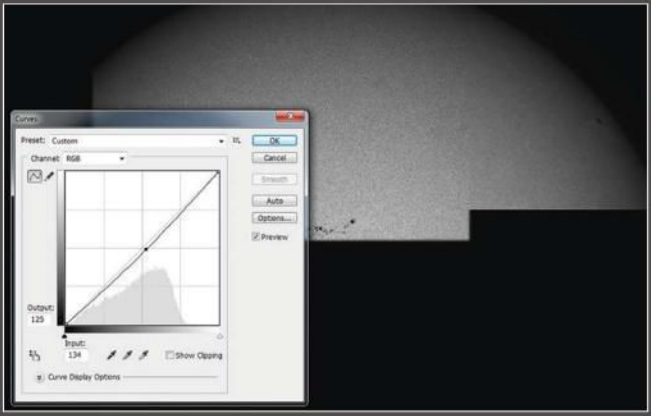
If your software allows, reduce the gamma on the image to make the Sun's surface easier to see. A green or solar continuum filter over a monochrome camera can enhance solar granulation. Record 500-800 frames for each section of the Sun: make sure the captures overlap. Process each using a registration and stacking program.



Normal
Opacity: 100%
Lock:
Fill: 100%

STEP 4

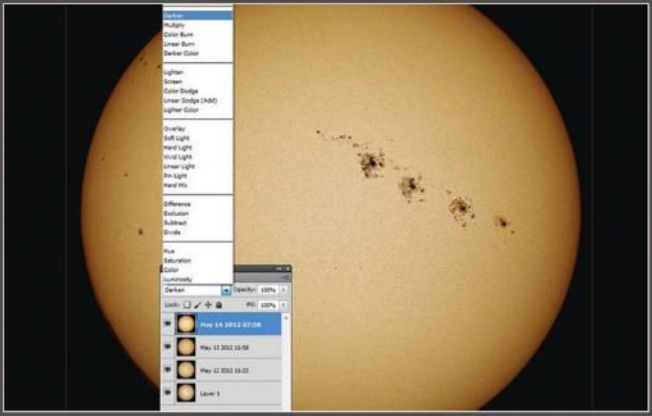
Load the first processed frame into a layer-based graphics editor and crop off any white borders. Increase the canvas size with a black background to accommodate the final image size. Open an adjoining frame and draw a selection box around the image that cuts off the border. Paste this into the base frame as a new layer.



Preset: Custom
Channel: RGB
☑ Preview
Output: 125
Input: 134
☐ Show Clipping

STEP 5

Align the upper layer using surface detail. If there are no sunspots, try using solar granulation – it's tricky, but possible! Move the upper layer roughly into position then toggle its visibility on and off to align. Once done, use the Curves tool to match tones approximately. Remove any sharp overlaps using an eraser set to 10 per cent.



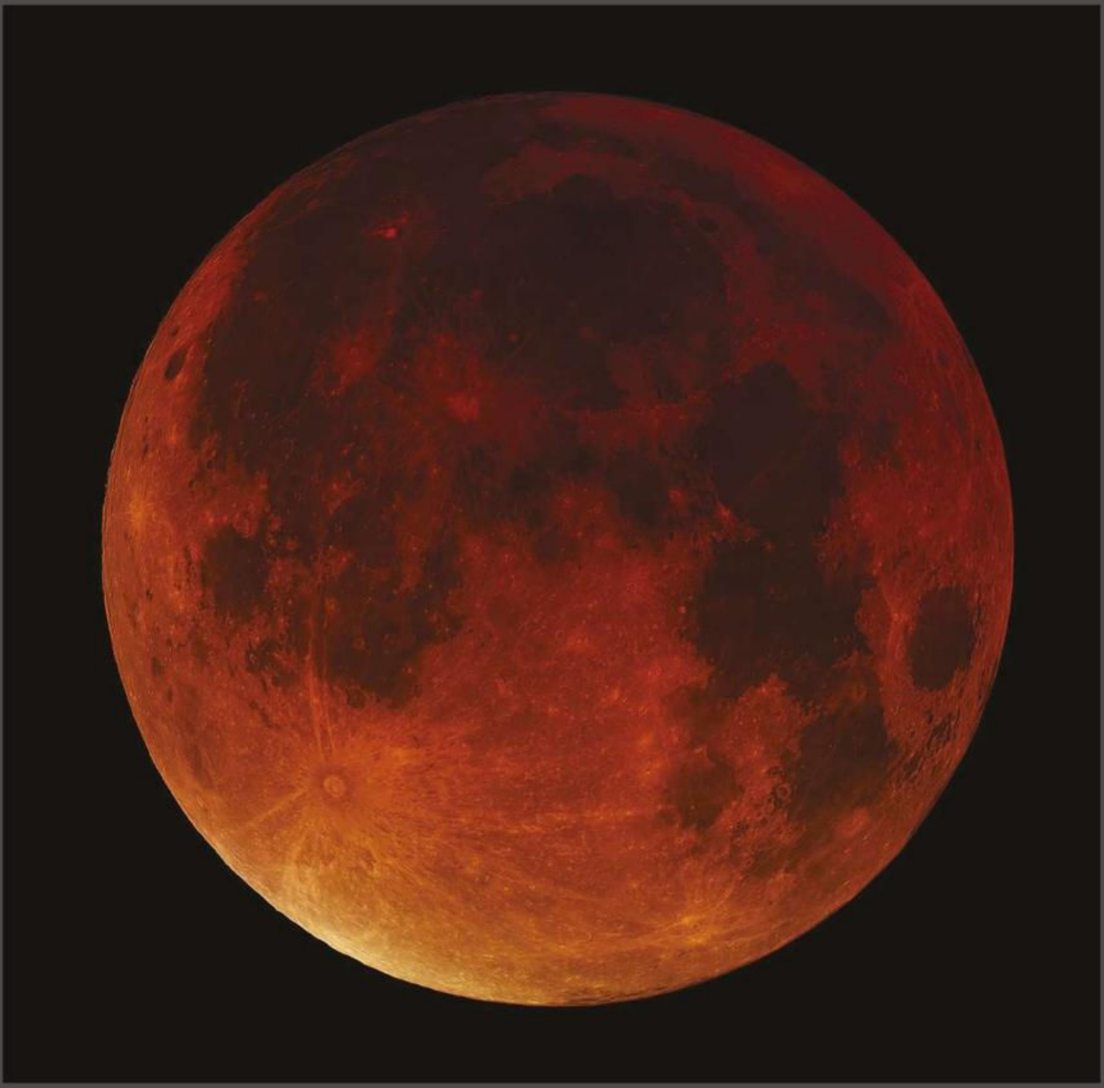
Darken
Opacity: 100%
Lock:
Fill: 100%

STEP 6

Repeat for all mosaic frames then flatten the image. Taking a sequence of white light mosaics over several days allows you to reveal the Sun's motion: load each mosaic into your graphics editor, in order, as separate layers. Align them, and set the blend mode of all upper layers to 'Darken' to show the spots on the layers below.

THE MOON

Earth's constant companion in the sky is a tempting target for photographers. Whether you choose to fit the entire disc of the full Moon into your shot, or wait until it has moved on in its phases and the Sun is low in the lunar sky, casting dramatic shadows, there's always something to see. If you focus tightly on the craters, seas and mountain ranges that give the Moon's surface so much of its interesting texture, you can resolve detail you could never possibly see with the naked eye. Waiting for a lunar eclipse can also lead to striking images, as the shadow of the Earth creeps over the Moon's face and finally, at the moment of totality, our satellite takes on a ghostly red colour.



▲ LUNAR ECLIPSE TOTALITY

KEITH BRAMLEY, PILLING, LANCASHIRE, 28 SEPTEMBER 2015

Keith says: "This was taken from my back garden using my home-made pier setup. I imaged up to totality every four minutes and found I had to adjust the exposure quite drastically close to totality to get any detail."

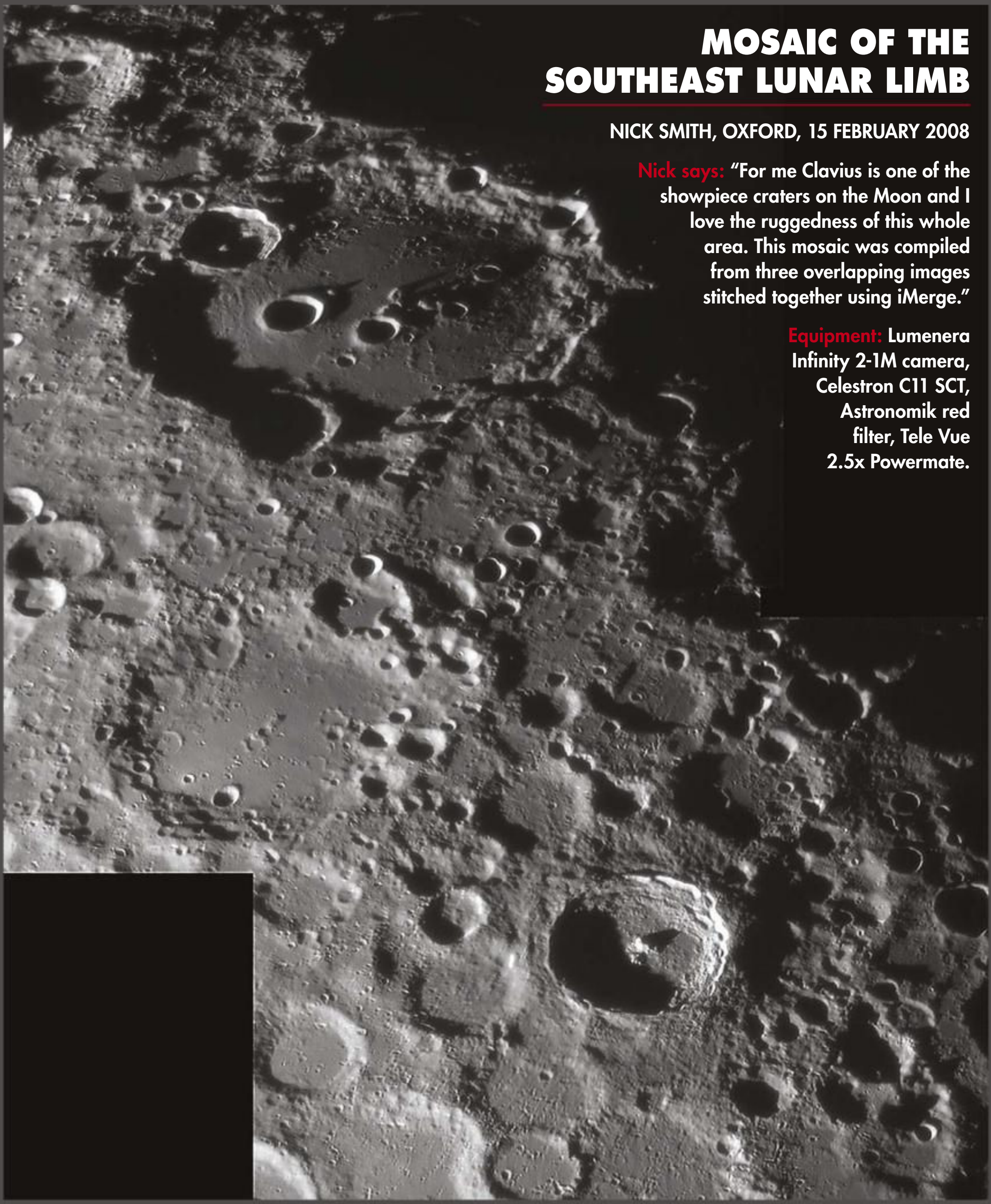
Equipment: Canon EOS 450D DSLR camera, Sky-Watcher MN190/1000 Maksutov-Newtonian telescope.

WAXING LUNAR MOSAIC ▶

ANDRE VAN DER HOEVEN, THE NETHERLANDS, 3 MARCH 2012

Andre says: "I went over the Moon with the telescope step by step to record every little bit of it. It took me over 90 minutes and 107 videos to catch the whole Moon. The seeing was spectacular that night."

Equipment: Imaging Source DMK 21AU618.AS CCD camera, Celestron C11 Schmidt-Cassegrain telescope.



MOSAIC OF THE SOUTHEAST LUNAR LIMB

NICK SMITH, OXFORD, 15 FEBRUARY 2008

Nick says: "For me Clavius is one of the showpiece craters on the Moon and I love the ruggedness of this whole area. This mosaic was compiled from three overlapping images stitched together using iMerge."

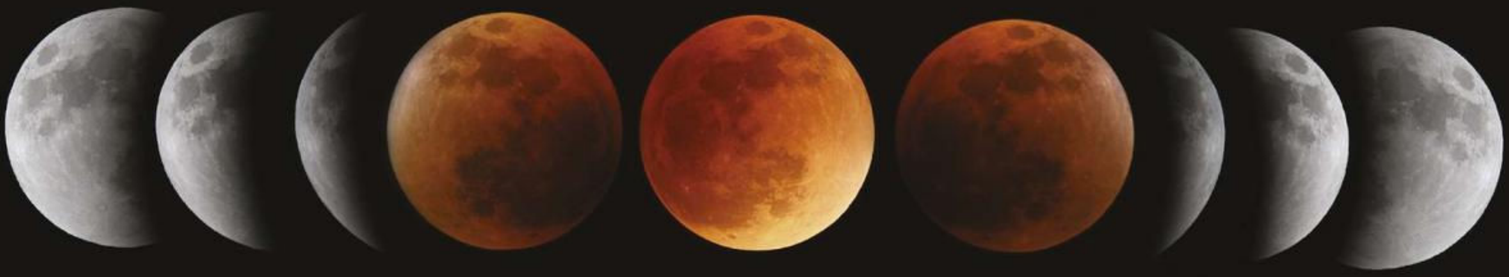
Equipment: Lumenera Infinity 2-1M camera, Celestron C11 SCT, Astronomik red filter, Tele Vue 2.5x Powermate.

▼ TOTAL LUNAR ECLIPSE

PHILLIP HOLMES, ROCKHAMPTON, AUSTRALIA, 28 AUGUST 2007

Phillip says: "I will never forget that night. I was lucky enough to have my local TV station come around and film me taking photos of the eclipse for the news broadcast. I also had people coming in off the street to see this truly stunning event.

Equipment: Canon EOS 30D DSLR camera, Tele Vue NP 101mm refractor.

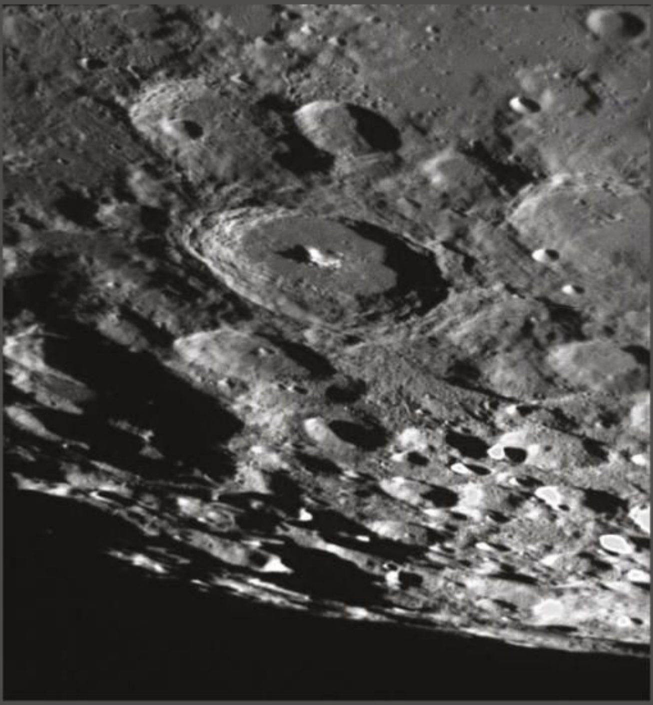


CRATER MORETUS ▶

DAVID FINNIGAN, WEST MIDLANDS, 7 DECEMBER 2008

David says: "This is a composite of two images taken between 17.40 and 17.42, two days past the Moon's first quarter phase. The seeing conditions were good, so I was able to get a high focal length image with relative ease."

Equipment: Imaging Source DMK 21AU04.AS CCD camera, 8-inch Meade LX200 Classic, 2.5x Tele Vue Powermate, red filter.

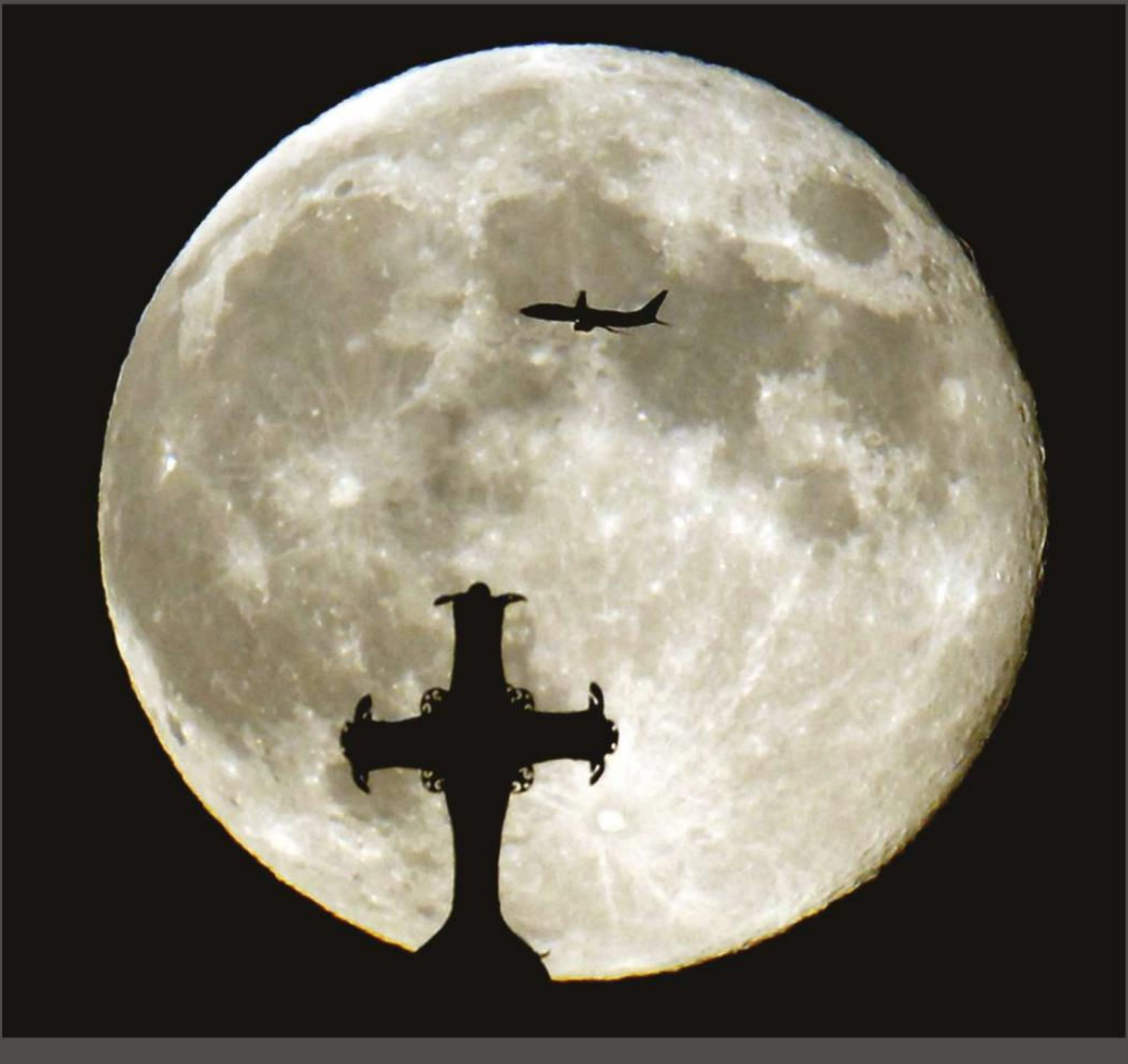


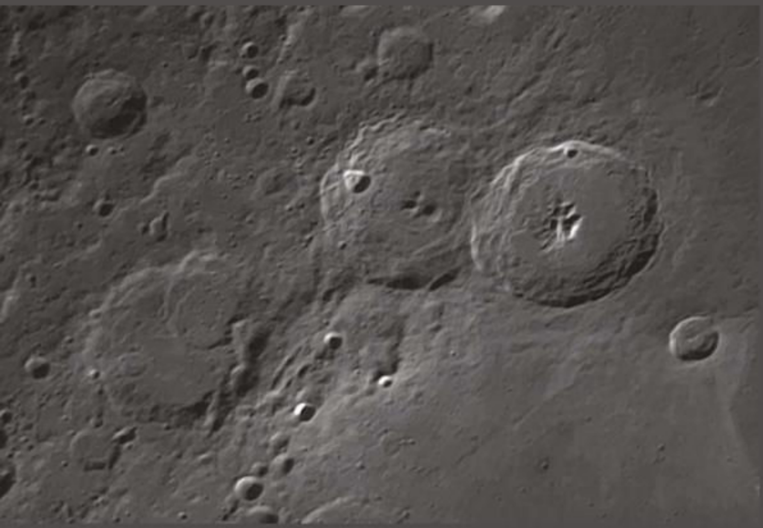
▼ MOON RISING OVER ST PAUL'S CATHEDRAL

ALISDAIR MACDONALD, LONDON, 16 NOVEMBER 2005

Alisdair says: "I was pleased that I managed to align the Moon with the cross on top of St Paul's dome. Then, as I was taking the picture, a plane flew across the Moon."

Equipment: Nikon D2X DSLR camera, 800mm Nikon lens.





▲ CRATER THEOPHILUS

TREVOR LITTLE, SOUTHWICK, SUSSEX, 13 FEBRUARY 2008

Trevor says: "Theophilus is a large impact crater near Mare Nectaris, named after the fourth century Greek philosopher. It's flanked by the craters Cyrillus and Catharina."

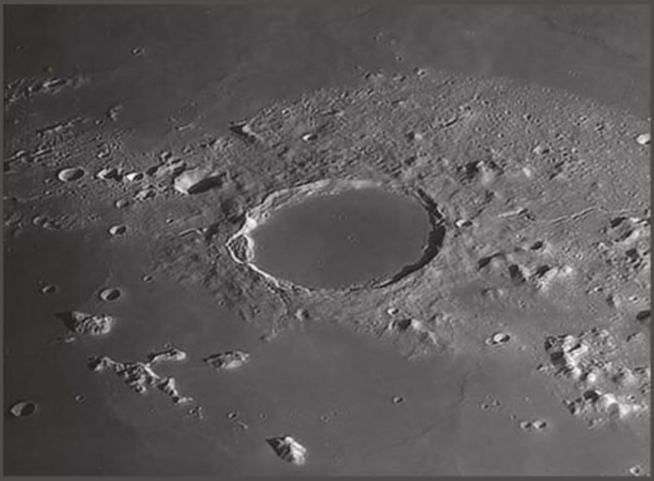
Equipment: Imaging Source DMK CCD camera, Celestron C11 at f/10.

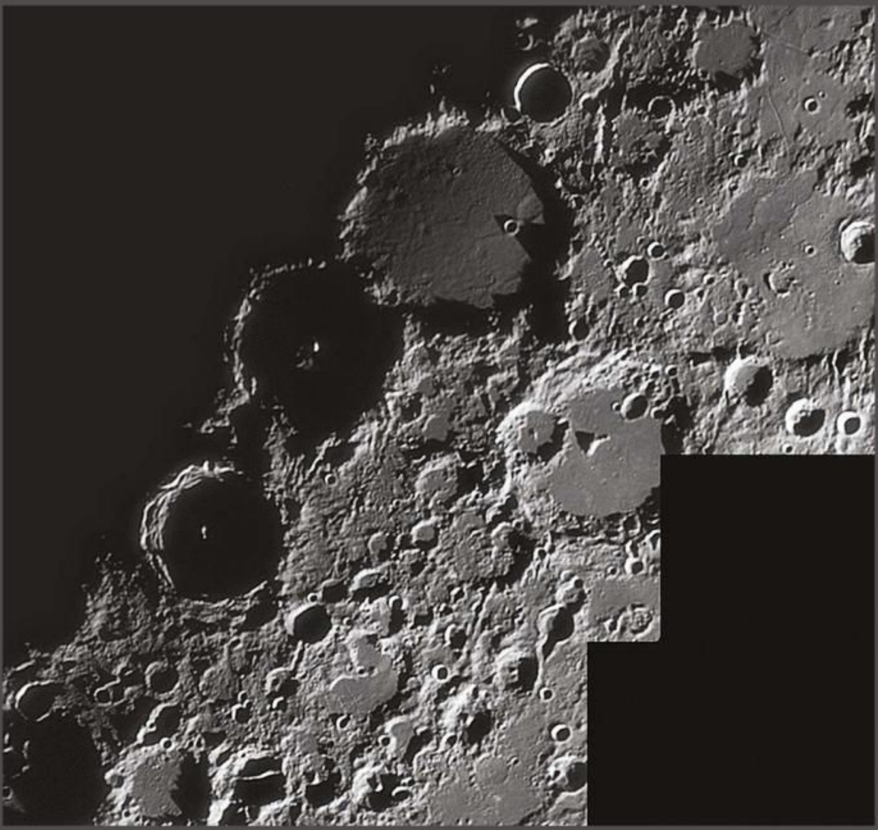
▼ LUNAR CRATER PLATO

JAMES JEFFERSON, FLACKWELL HEATH, BUCKINGHAMSHIRE, 16 FEBRUARY 2008

James says: "I've never had the fortune of imaging this crater in the past due to cloud or bad seeing. However, on this night everything went to plan."

Equipment: Lumenera 075M camera, Celestron 9.25-inch telescope, 2x Barlow lens.





▲ CRATERS PTOLEMAUES, ALPHONSUS AND ARZACHEL

TREVOR NURSE, NORFOLK, 25 FEBRUARY 2010

Trevor says: "I just happened to image the Alphonsus area at the right time. The Sun was illuminating fine detail on the crater floor. I normally see a flat expanse with the exception of a few small craters; I've never seen this level of detail."

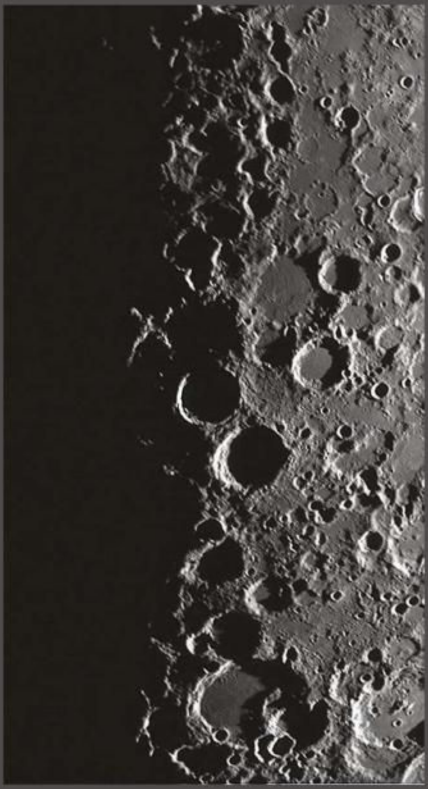
Equipment: Imaging Source DMK 21 CCD camera, Sky-Watcher 6-inch refracting telescope, 2x Barlow lens.

▼ THE LUNAR 'X'

ANDY ROBINSON, DAWLISH, DEVON, 22 MARCH 2010

Andy says: "Visible for four hours each lunar cycle, the lunar 'X' is at its best for only about an hour, so I was very lucky to have caught the event in good seeing."

Equipment: Imaging Source DMK 21 CCD camera, Celestron C11 Schmidt-Cassegrain telescope.

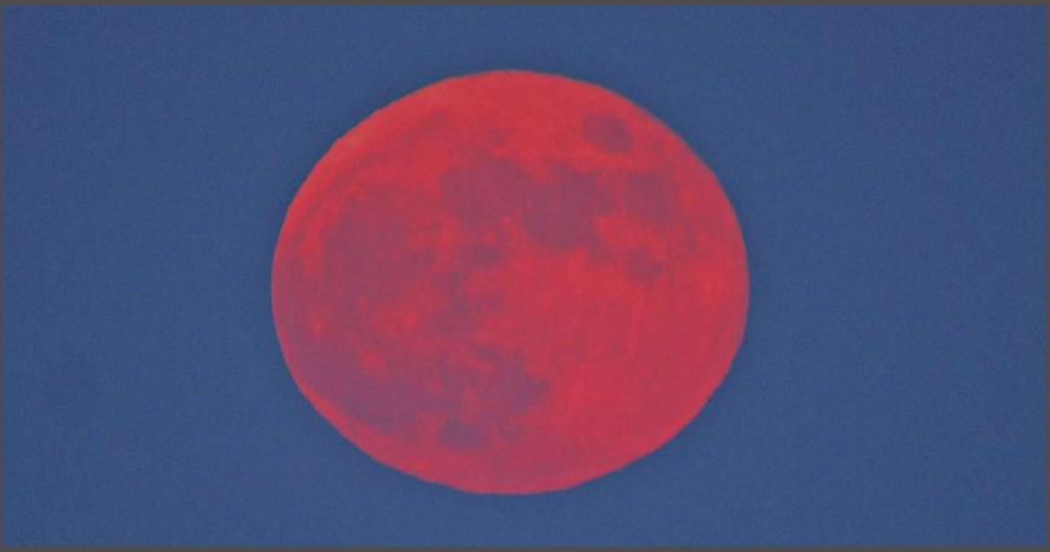


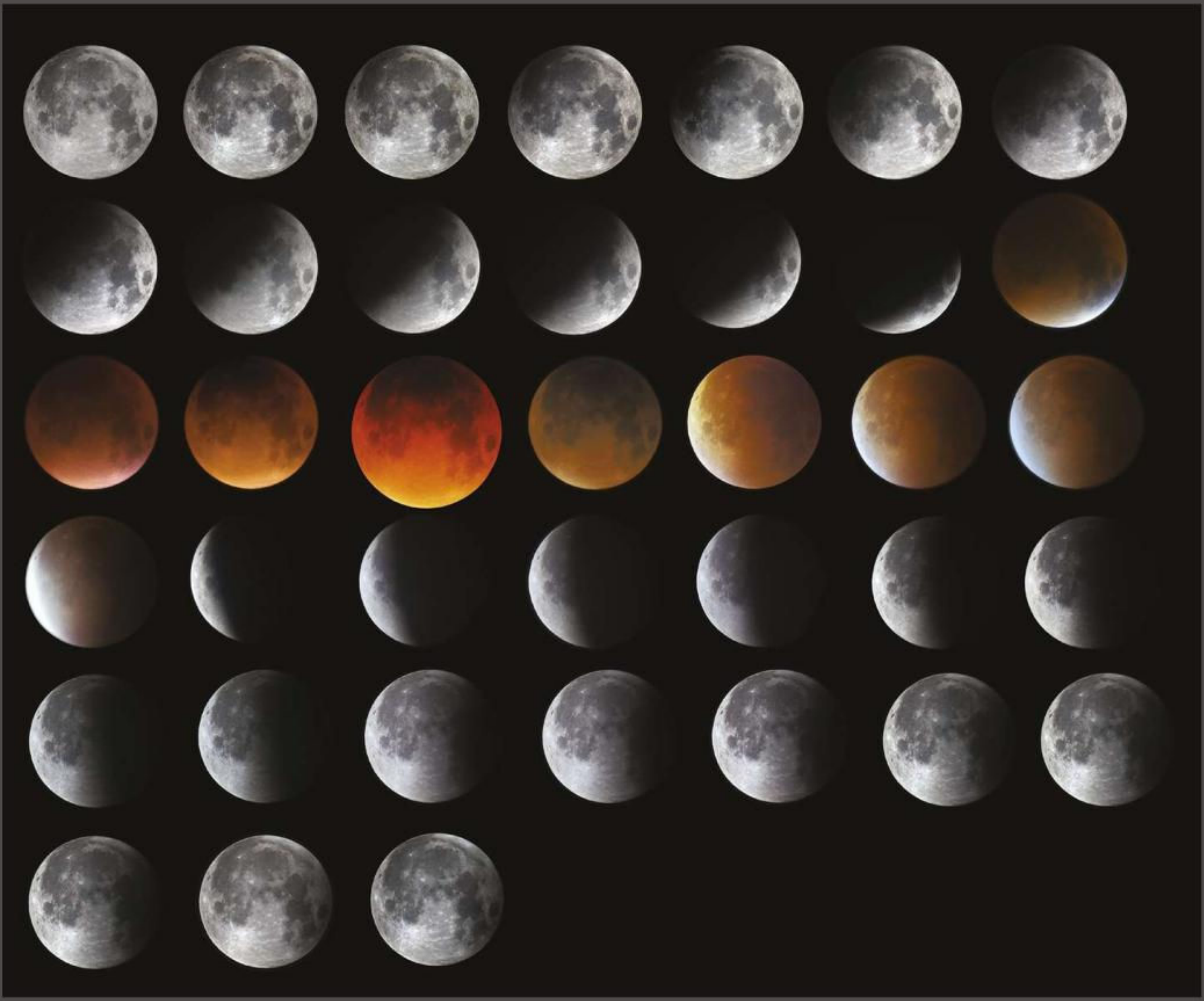
A 'PUMPKIN' MOON ▶

STEFANO DE ROSA
FRANCE, 26 JUNE 2010

Stefano says: "This picture shows the full Moon rising over the sea horizon of Cap Ferrat, France. The reddish Moon appeared as a huge pumpkin in the sky as a consequence of light refracting in the atmosphere."

Equipment: Canon EOS 1000D DSLR camera, 150-500mm Sigma lens at 500mm and f/6.3.





▲ A BEAUTY IN EARTH'S SHADOW

RALPH SMYTH, LISBURN, COUNTY ANTRIM, 28 SEPTEMBER 2015

Ralph says: "The weather leading up to the start of the eclipse was worryingly cloudy, but I was determined to stay up and capture as much of it as possible. Fortunately the weather cleared and I captured a sequence of images that I assembled into this montage, deliberately making the image around mid-totality a little larger than the others. The Moon was a lovely bright copper colour at this point. I am pleased with the images and feel very fortunate to have been able to record this beautiful event."

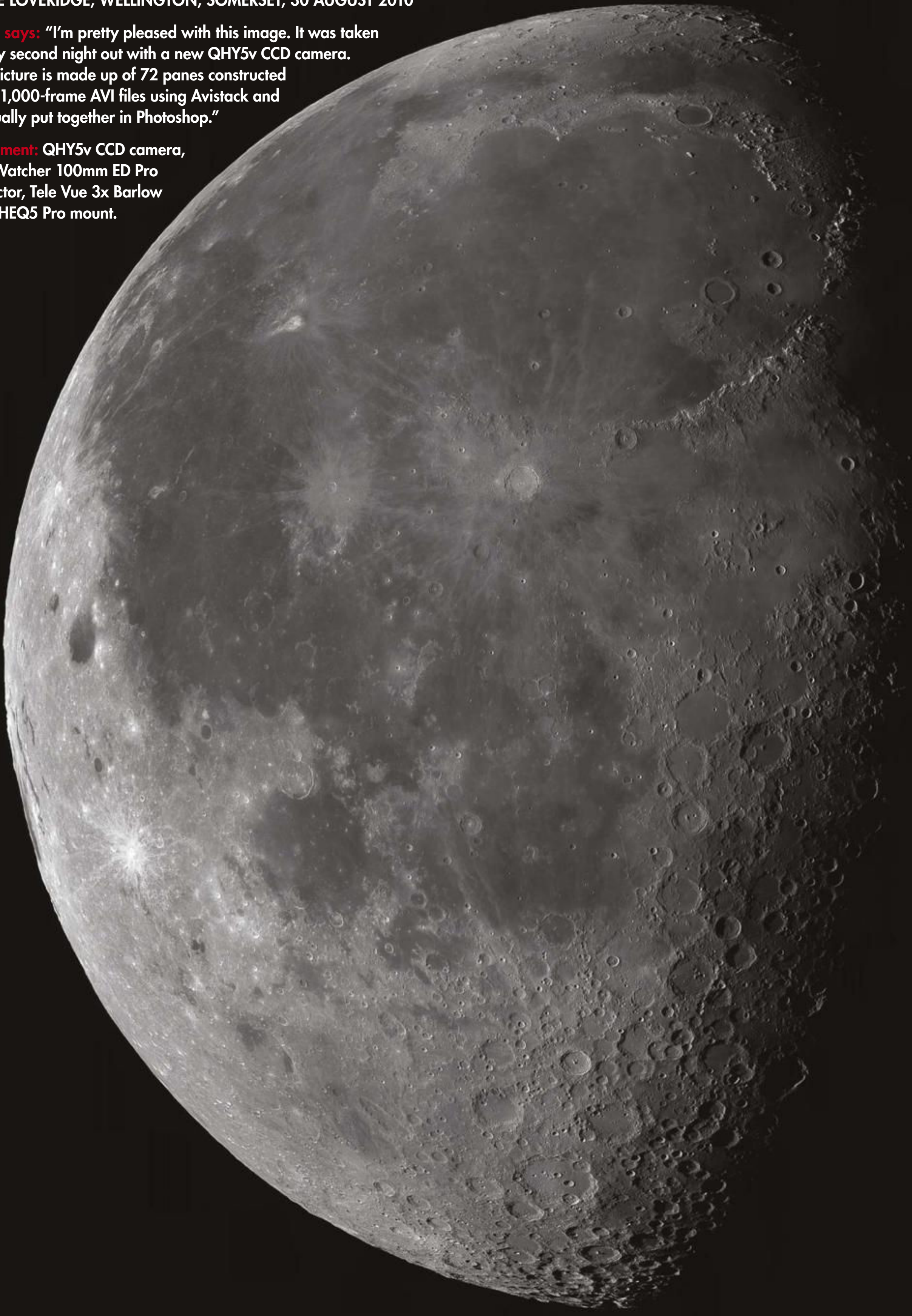
Equipment: Canon EOS 1000D DSLR camera, Sky-Watcher Evostar ED80 Pro refractor, Sky-Watcher HEQ5 Pro SynScan mount.

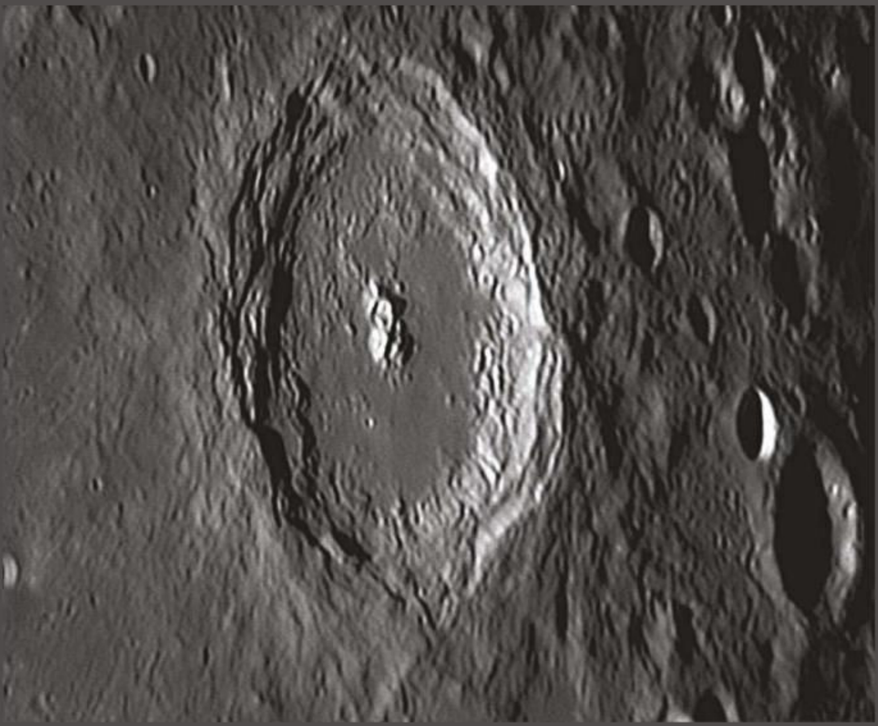
WANING MOON MOSAIC

STEVE LOVERIDGE, WELLINGTON, SOMERSET, 30 AUGUST 2010

Steve says: "I'm pretty pleased with this image. It was taken on my second night out with a new QHY5v CCD camera. The picture is made up of 72 panes constructed from 1,000-frame AVI files using Avistack and manually put together in Photoshop."

Equipment: QHY5v CCD camera, Sky-Watcher 100mm ED Pro refractor, Tele Vue 3x Barlow lens, HEQ5 Pro mount.





◀ CRATER LANGRENUS

PAUL MELLOR, CONGLETON, CHESHIRE, 17 NOVEMBER 2005

Paul says: "I imaged the crater close to the terminator so that the low-angle light showed a lot of detail in the walls and on the floor of Langrenus."

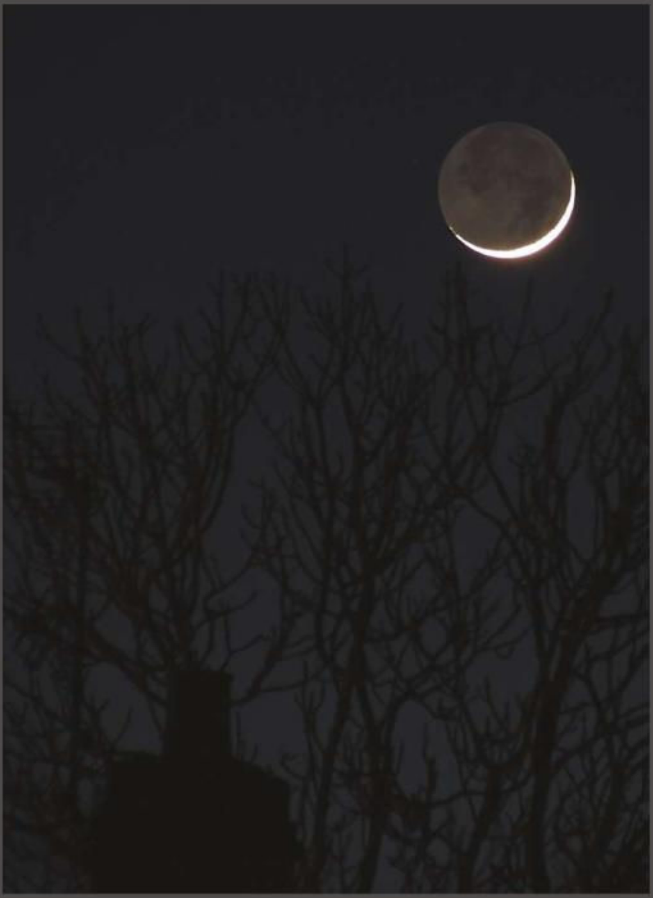
Equipment: Philips Toucam Pro 2 webcam, 8-inch Meade SCT.

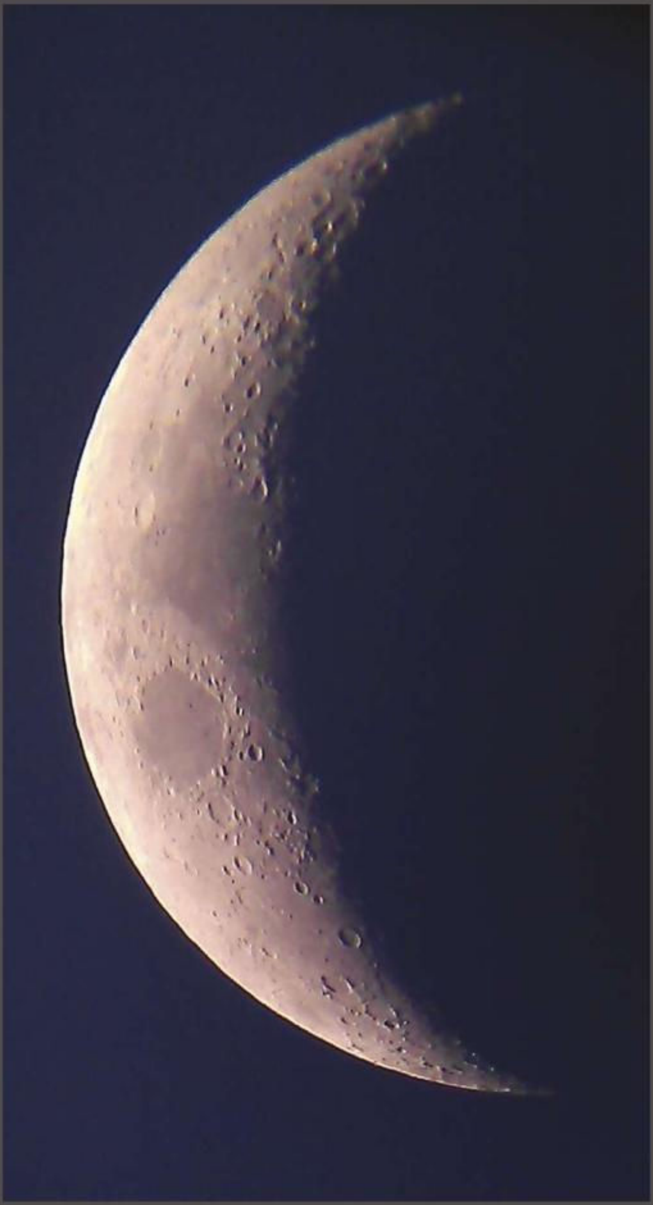
▼ WAXING MOON

CALLUM PENNINGTON, ST HELENS, MERSEYSIDE, 23 MAY 2015

Callum says: "This is quick image I took of a waxing crescent Moon. The image is laterally inverted since I use a reflector and I had to alter the exposure of my mobile phone in order to capture it."

Equipment: Smartphone camera, Sky-Watcher Explorer-130 Newtonian reflector, EQ2 equatorial mount, HookUpz universal smartphone adaptor.





▲ A TWO DAY OLD MOON

MARTIN MCKENNA, MAGHERA, COUNTY DERRY, NORTHERN IRELAND, 20 MARCH 2007

Martin says: "I noticed a prominent break in the lower left portion of the sunlit limb, which is probably caused by a large mountain or crater rim blocking the sunlight. I have never seen this effect on a crescent Moon so vividly before!"

Equipment: Fujifilm Finepix S5600 camera.

◀ COLOUR-SATURATED MOON

SCOTT PHILLIPS, LLANELLI, SOUTH WALES, 28 JANUARY 2015

Scott says: "I wanted to edit my Moon shots a little differently and came across a stunning colour-saturated full Moon picture online, so decided to try this approach out on my waxing crescent shot."

Equipment: Olympus E-450 camera, Sky-Watcher Explorer 130 EQ2 telescope, 13 percent Moon filter.

▲ THE LUNAR SOUTH POLE

KOSTAS KALIMAFTSIS, THESSALONIKI, GREECE, 15 JULY 2009

Kostas says: "I really like the tones and the sharpness, thanks to exceptionally good seeing that morning. A very favourable libration helped me capture this less elliptical view of Clavius."

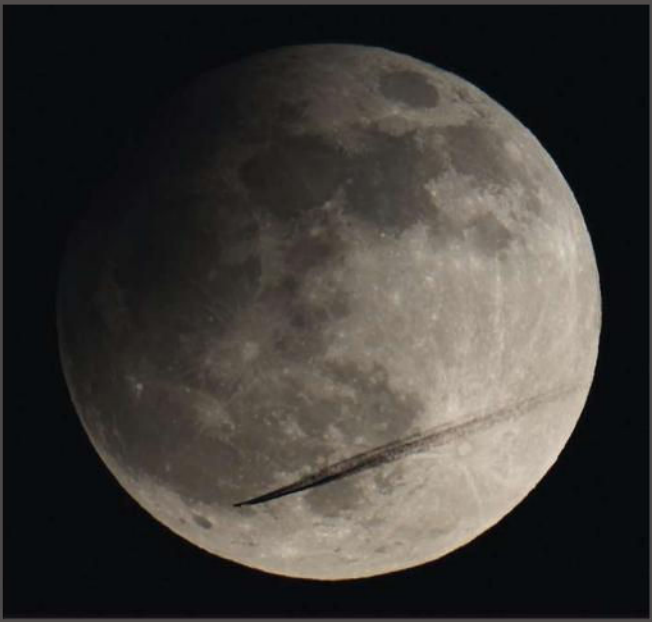
Equipment: Canon 450D DSLR camera, Sky-Watcher Mak 180, HEQ5 mount.

THE MOON AND JUPITER

LUIS ARGERICH, ARGENTINA, 2 NOVEMBER 2012

Luis says: "This was a very beautiful conjunction and looked even better through binoculars. I took different exposures for the Moon, Jupiter and its moons, and then made a high dynamic range image."

Equipment: Canon EOS 60D DSLR camera, Stellarvue SV80ED refractor.



◀ PLANE CONTRAIL THROUGH A PARTIAL LUNAR ECLIPSE

PHILIP CORNEILLE, BELGIUM, 25 APRIL 2013

Philip says: "On 25 April 2013, at around 22:10 local time, the partial lunar eclipse was at its maximum. The Moon only traveled 1.3 per cent into the centre of the Earth's shadow, the umbra."

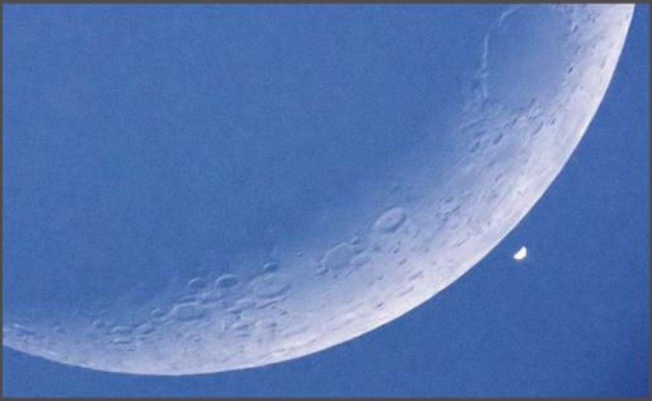
Equipment: Canon EOS 600D DSLR camera, 130mm triplet apochromatic refractor.

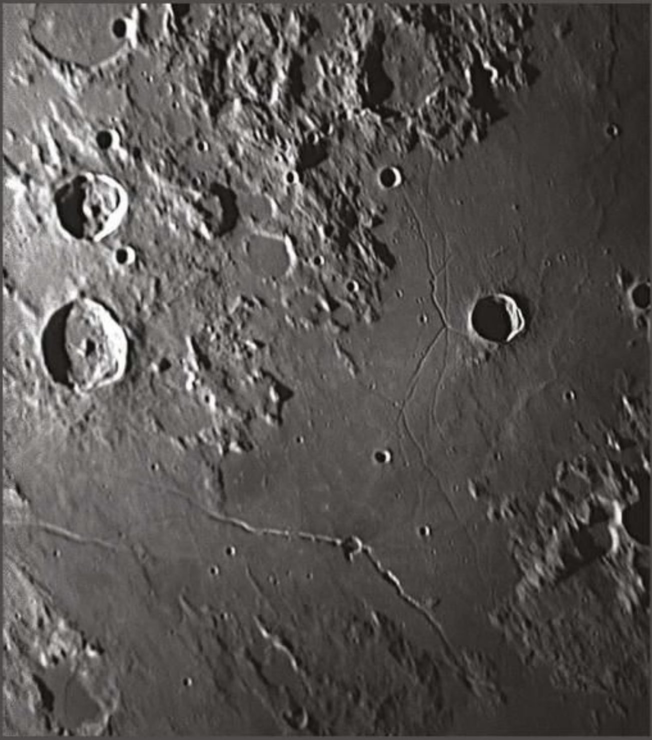
▼ AN OCCULTATION OF VENUS BY THE MOON

ANTHONY AYIOMAMITIS, ATHENS, GREECE, 18 JUNE 2007

Anthony says: "Through the telescope's finderscope, Venus's phase was easily discernible. The 3.5-day-old Moon was also a pleasant sight, with the thin crescent brilliantly set against the rich blue sky."

Equipment: Canon EOS 300D digital SLR camera, Astro-Physics 160mm f/7.5 Starfire EDF telescope, Baader IR-Cut filter.





▲ HYGINUS AND TRIESNECKER RILLES

PHILIP WITHERS, ROMSEY, HAMPSHIRE, 31 MAY 2009

Philip says: "I like this part of the Moon because it shows a wide range of different features in close proximity, including rimae, crater chains, mountains and plains peppered with numerous small craters."

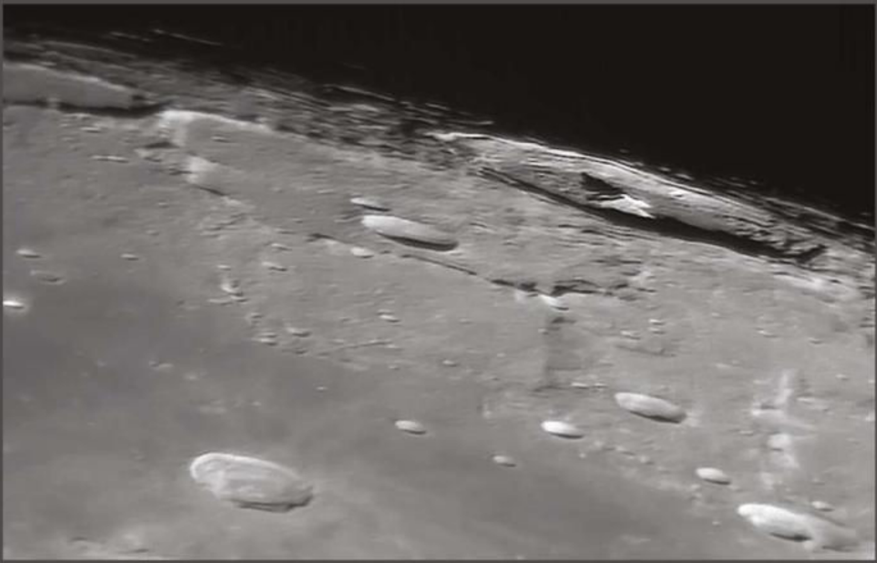
Equipment: Imaging Source DFK 31AU03 camera, 7-inch Meade apo refractor, x2 Barlow lens.

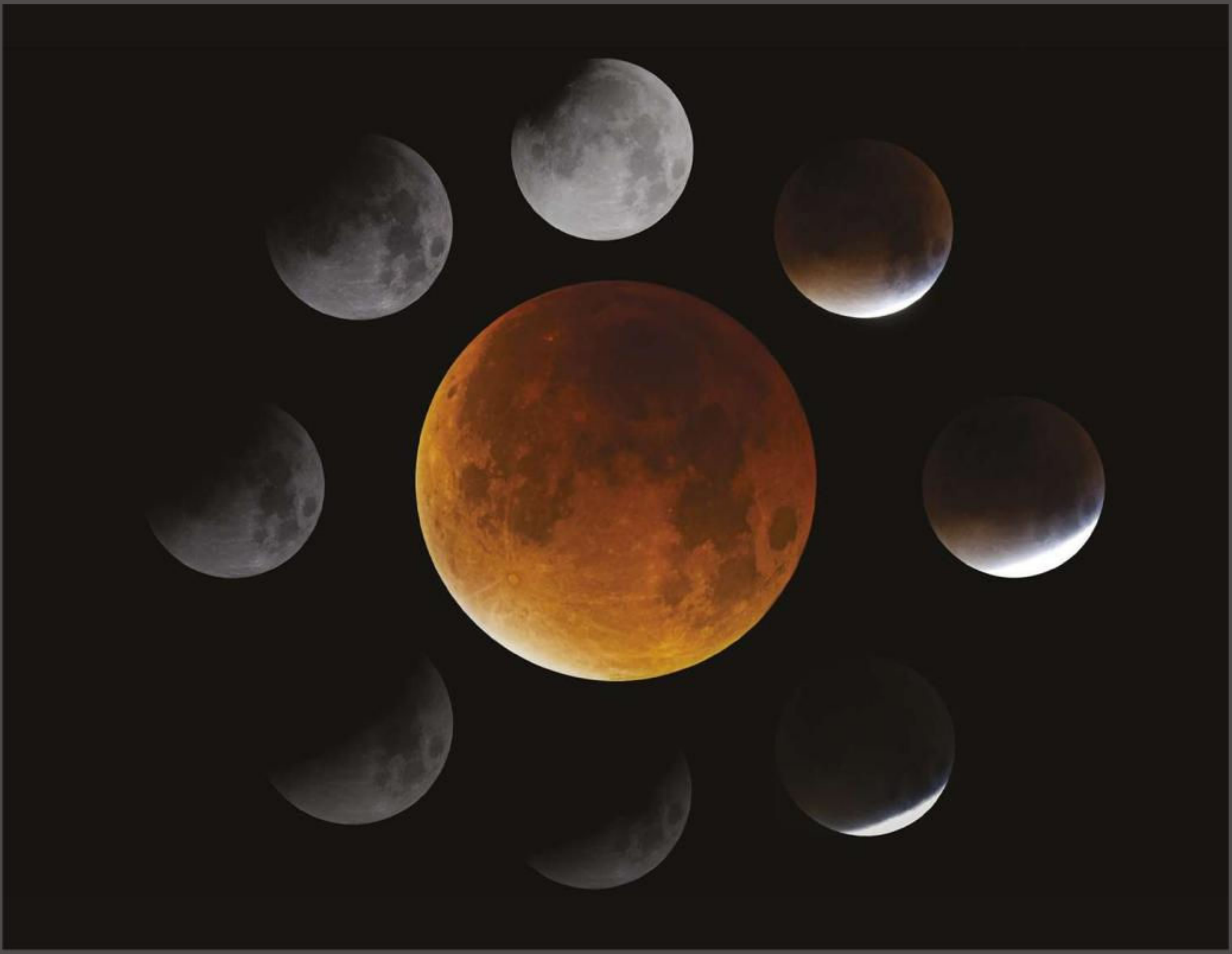
CRATER PYTHAGORAS ▶

DAVE MOULTON, NORTH WALES, DECEMBER 2008

Dave says: "I find Crater Pythagoras and the surrounding area very interesting. The general topography of the region, plus the double central peak and terraced walls of the crater rim, remind me of the lunar views that got me interested in astronomy as a child."

Equipment: Lumenera 075M camera, Meade 10-inch SCT, Sky-Watcher EQ6 Pro mount.





▲ LUNAR ECLIPSE

HOUSSEM KSONTINI, TUNISIA,
28 SEPTEMBER 2015

Houssem says: "I took the image in Ain Zaghouan near Tunis from 1.05am to 2.50am. I received my telescope three months ago and this my first eclipse, so I tried to enjoy it and do my best. As the luminosity of the Moon changes continuously during an eclipse, the main difficulty was to be careful when changing the exposure time to not overexpose it."

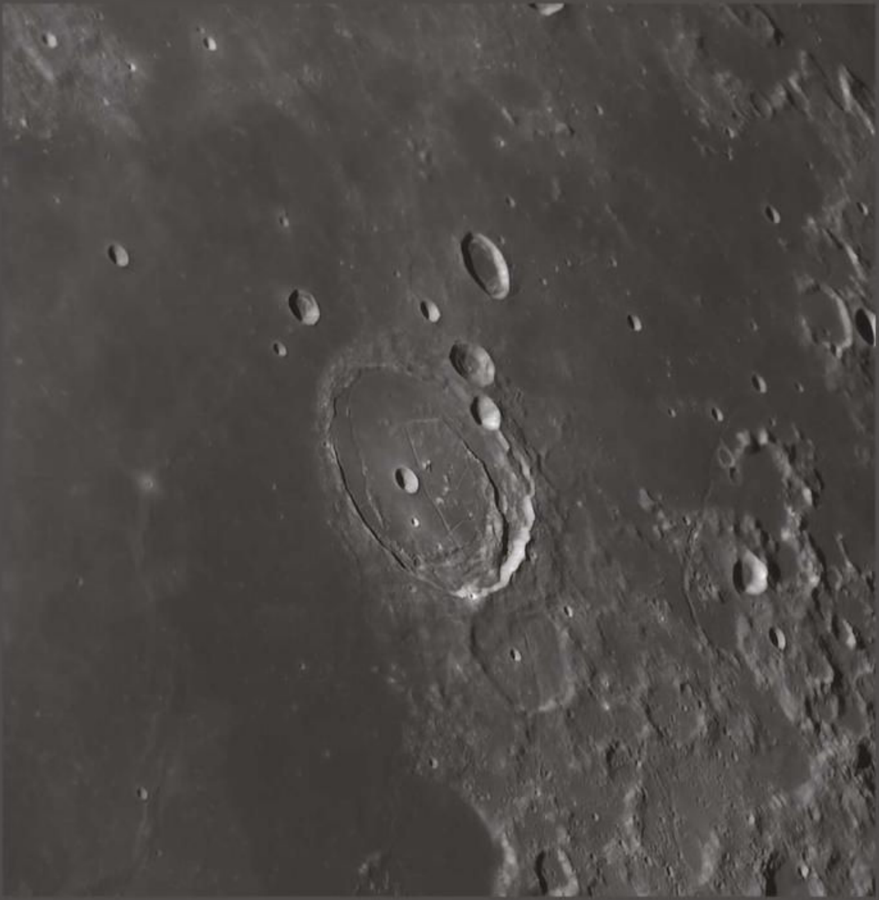
Equipment: Nikon D3000 DSLR camera, Sky-Watcher N 150/750 Explorer Newtonian reflector, NEQ3-2 mount.

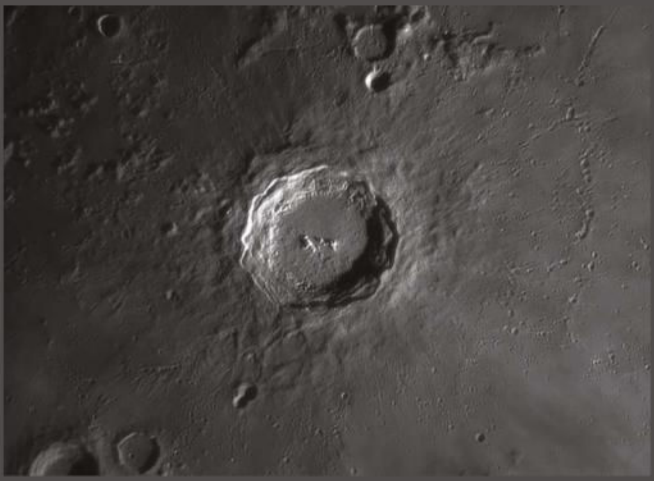
CRATER POSIDONIUS ▶

RICHARD BOSMAN, ENSCHEDE,
NETHERLANDS, 18 SEPTEMBER 2008

Richard says: "It fascinates me how a large crater like Posidonius shows the devastating effects of lava floes. The surrounding sea, Mare Serenitatis, hints at an eventful period in the Moon's history."

Equipment: Imaging Source DMK 31 CCD camera, Celestron 280mm SCT, 2.5x Barlow lens.





◀ CRATER COPERNICUS

MICK HYDE, SWINDON, 7 DECEMBER 2008

Mick says: "The seeing was so bad I was amazed that I captured anything at all, let alone detail in Copernicus."

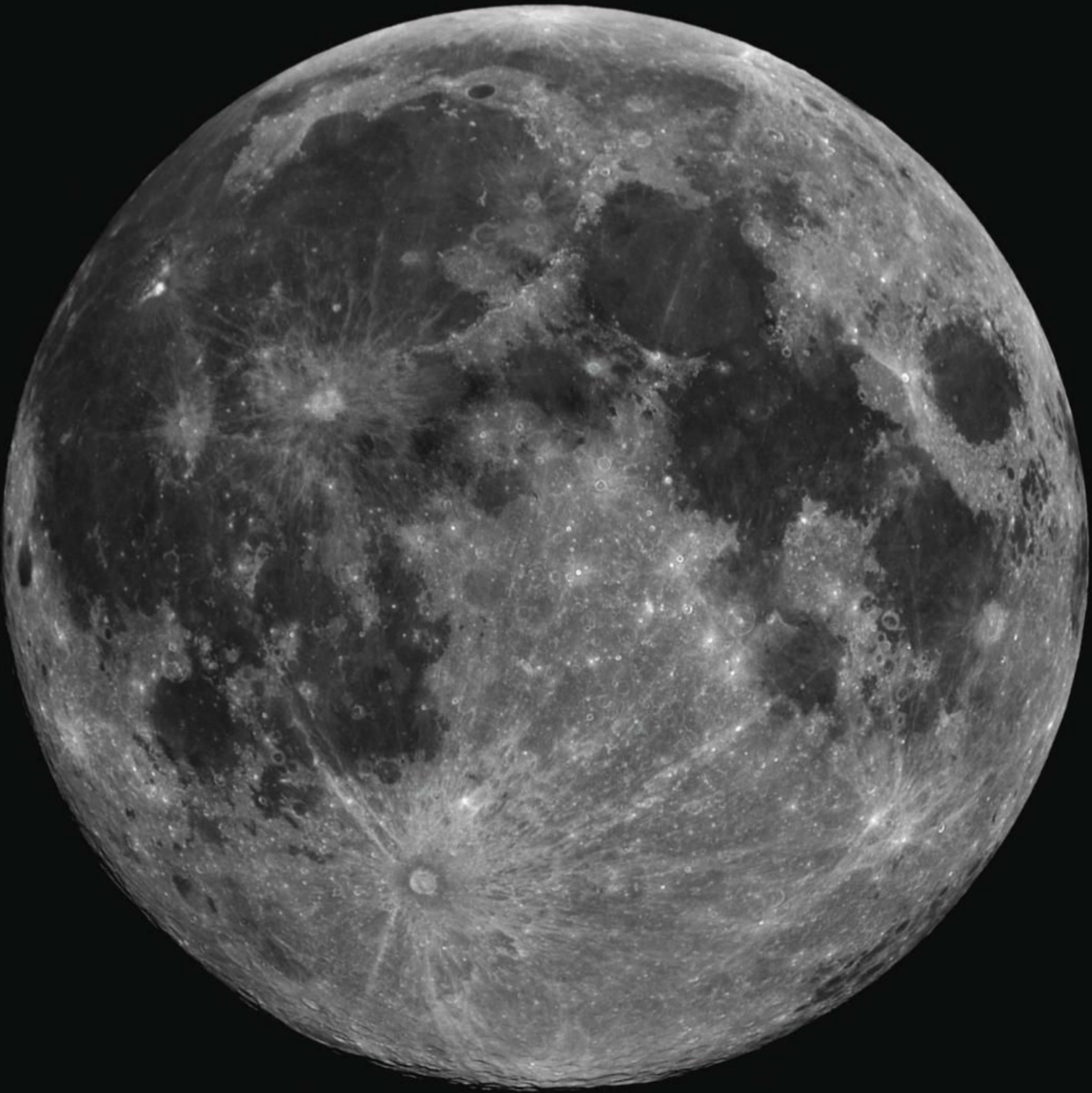
Equipment: Celestron 9.25-inch SCT, 2.5x Tele Vue Powermate, red filter.

▼ FULL MOON

STEVE WARD, RED LODGE, SUFFOLK, 1 AUGUST 2012

Steve says: "I'm always amazed by the brightness of the full Moon on a clear night. It's easily light enough to read by."

Equipment: Canon EOS 1000D DSLR camera, Sky-Watcher ED80 Pro refractor, 1.8x Barlow lens, EQ3-2 mount.



Starlight Xpress USB Filter Wheels

The USB filter wheel was first introduced in 2009 and adds many new features to a useful imaging accessory. It is unique in that it does not require a separate power supply, the high performance DC gear motor runs entirely from the USB supply and consumes less than 100mA.

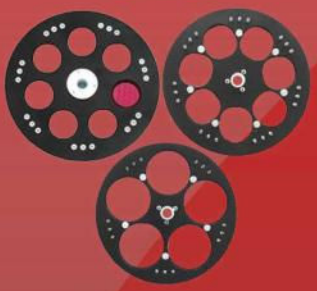
The wheel is light and slim, with an easy system of thumbscrews to swap the filter carousel without tools. Each of the telescope and camera adaptors can be rotated to any angle before locking down, so that you can orient the wheel and camera into the optimum position.

The wheel is quiet in operation and the Hall-Effect 3bit encoded positioning gives accurate filter locations. You are able to swap filter carousels easily and the new carousel is recalibrated every time the USB connection is made.

In our usual style, Starlight Xpress have ensured that this new product can also interface with many other cameras on the market to make this a truly universal filter wheel.

Mini-USB Filter Wheel

This mini-USB filter wheel is a smaller and more compact version of the original filter wheel. It combines a built-in Off Axis Guider and has a total back focus of 55mm when used in conjunction with our TRIUS cameras. This is an ideal back focus for many field flatteners and focal reducers. When used in conjunction with the world renowned Lodestar X2 guide camera, finding a guide star is simple.



Maxi-USB Filter Wheel

The new Maxi filter wheel is primarily designed for large format camera, although we do cater for smaller cameras. This is our largest filter wheel and is capable of holding 7 x 50.8mm unmounted square filters. It also has the built in OAG and has a back focus of only 42mm (+ camera).

Key Features:

- No external power supply - powered by USB.
- DC micro-motor - no heavy & noisy stepper motors.
- Accurate filter positioning.
- Lightweight and strong - very low flexure.
- Simple carousel swapping - no tools required.
- Bi-directional rotation.
- Multiple filter carousel options - same filter wheel can be used with multiple CCD sizes.
- Multiple adaptors available for the Standard USB filter wheel and the Maxi filter wheel.

Filter Options:

Mini USB filter wheel – 5 x 1.25” filters or 5 x 36mm unmounted filters.
Standard USB filter wheel - 7 x 1.25”, 7 x 36mm unmounted, 5 x 2” filters & 5 x 50.8mm round unmounted filters.
Maxi USB filter wheel – 11 x 1.25” filters, 11 x 36mm unmounted filters, 9x 2” filters, 9 x 50.8mm unmounted filters & 7 x 50.8mm unmounted square filters.

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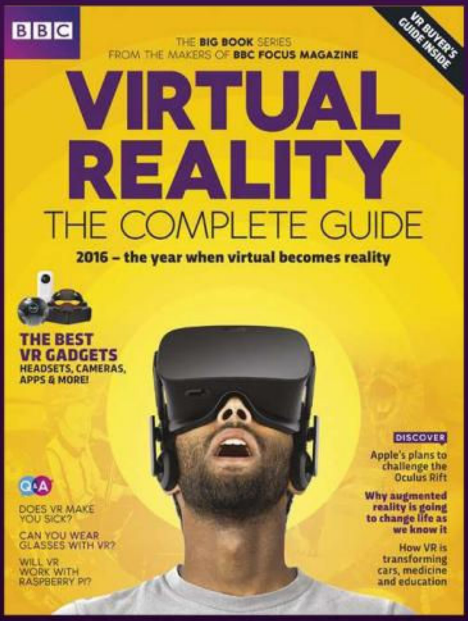
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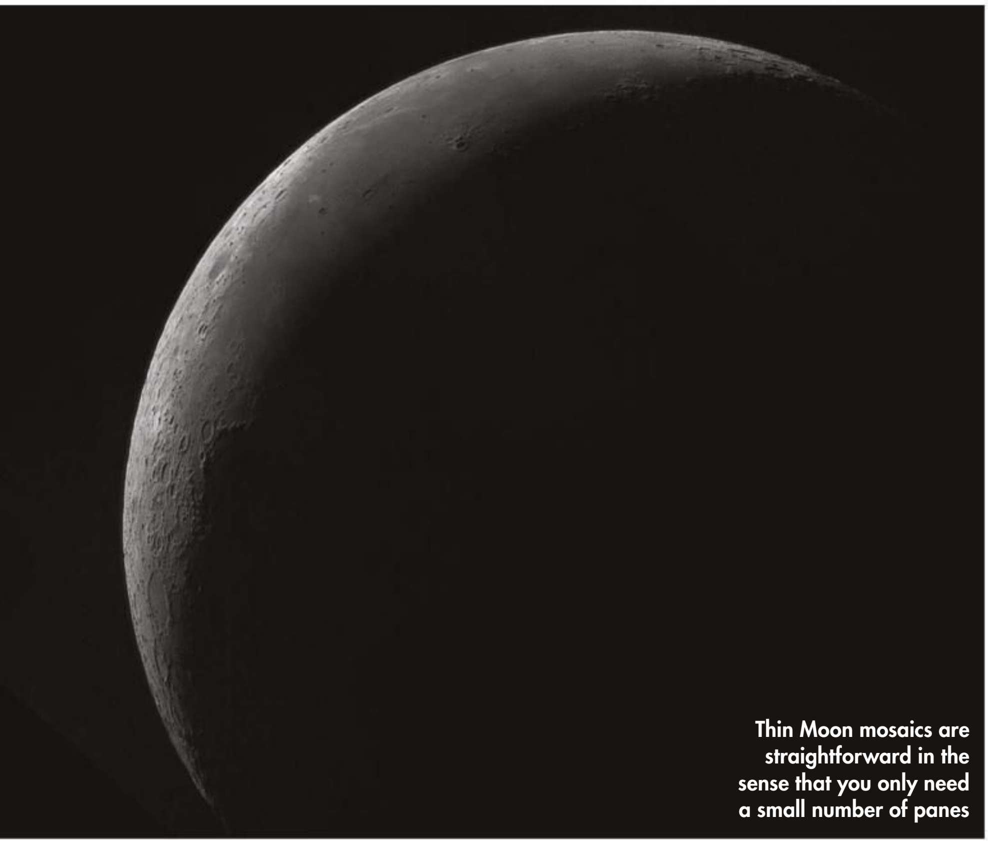
WORDS: PETE LAWRENCE

THIN CRESCENT MOON MOSAICS



Thin Moon mosaics are straightforward in the sense that you only need a small number of panes

RECOMMENDED EQUIPMENT

High frame rate camera, equatorially mounted and driven telescope with a focal length of 700mm or more, red or infrared-pass filter

There are opportunities to image a thin waning crescent Moon in almost every month of the year, so here we're going to take a look at how to create a mosaic of this sliver of light.

The thinnest Moon occurs just before new Moon, so the crescents that go before it are great to practice on and hone your technique to perfection.

You'll need a high frame rate camera in order to create the panes for the mosaic. This is basically an industrial strength webcam capable of taking lots of separate and consecutive still frames in a short period. The frames are typically stored in a movie file, which then needs to be 'distilled' into a single image. All the single images are then pieced together like a jigsaw. A layer-based image editor such as Photoshop is then used to tweak and blend the panes together, before the beautiful final crescent is revealed.

It's possible to capture images using either a colour or mono camera, though for dawn twilight crescents it would be prudent to use a red or even an infrared-pass filter. This will help reduce the brightness of the blue sky, so making the Moon stand out more. Using a monochrome filter in this way will reduce the efficiency of a colour camera so a mono camera is the preferred choice.

Minimalist mosaic

One big advantage of creating mosaics of a thin crescent Moon is that there's not much of it to image and process. This takes the pressure off somewhat when it comes to collecting the individual panes and, being easier to move around, there's less risk that you'll miss something. The thinner phases of the Moon can often be imaged in one staggered column of overlapping panes.

As the waning crescents get thinner, so they will appear lower down in the dawn twilight. The use of a high frame rate camera really comes into its own here because taking multiple frames, registering them against one another and averaging them together can help to reduce the effects of the poor seeing you'll experience when imaging objects at low altitude.

The capture process is relatively straightforward, with emphasis on making sure that your capture panes offer good overlap and that frames are not overexposed. Overlapping panes for a waning crescent Moon is slightly harder than it is for the waxing crescent which appears in the evening twilight. This is because the waning crescent Moon's surface is smoother, offering less in the way of shadowed relief features. The multitude of craters visible during the waxing phase make navigation around the lunar surface considerably easier.

Making sure that you're not overexposed is also a little more challenging for a waning crescent because a lot of the surface is the dark lava floor of Oceanus Procellarum. The challenge comes during the waning crescents that occur around three days after last quarter, when the bright crater Aristarchus can be seen and imaged. This is the brightest feature on the Earth-facing side of the Moon and it needs careful handling to make sure it doesn't appear burnt out.

Chasing the thin waning crescents towards new Moon is an interesting adventure in astrophotography. It starts relatively easy and adds new challenges. However, the fact that it holds your hand along the way really makes this one imaging project not to miss.

KEY TECHNIQUE

Chasing the thinnest of waning crescents is great fun because the Moon offers a natural training course to success. It starts a few days before new Moon in the form of a thicker and easier to locate crescent. Being relatively high in the dawn sky in darker twilight, it's easy to image. The difficulty then ramps up over the next few mornings. However, your previous efforts really help out, making the job of locating the Moon and getting the right shot easier. Follow it through, and the final mosaic will be easier to achieve.

ALL PICTURES: PETE LAWRENCE

STEP BY STEP GUIDE

STEP 1

First, select your equipment. A focal length around 1,000mm is ideal for basic mosaics. Higher focal lengths will increase image scale and up the complexity, but will give a more impressive result. Your telescope should ideally be mounted on a driven, polar-aligned mount. Focus on the Moon and make a note of the focus position ready for the next morning.

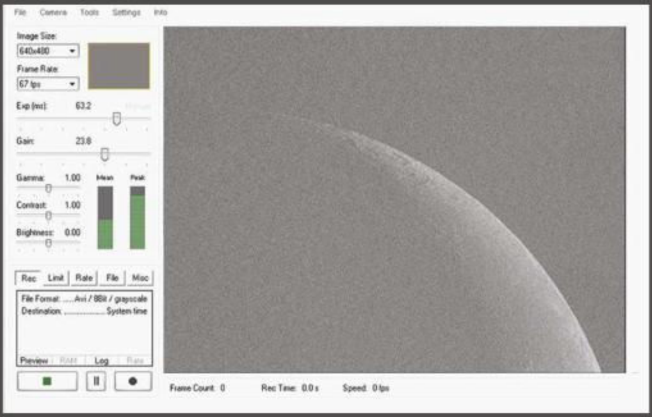
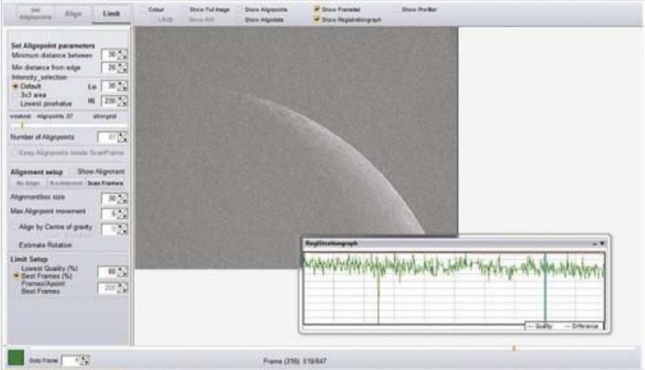


Image Size: 640x480
Frame Rate: 67 fps
Exp (ms): 63.2
Gain: 23.8
Gamma: 1.00
Contrast: 1.00
Brightness: 0.00
File Format: ......Avi / 8Bit / grayscale
Destination: ....System time
Frame Count: 0
Rec Time: 0.0 s
Speed: 0 fps

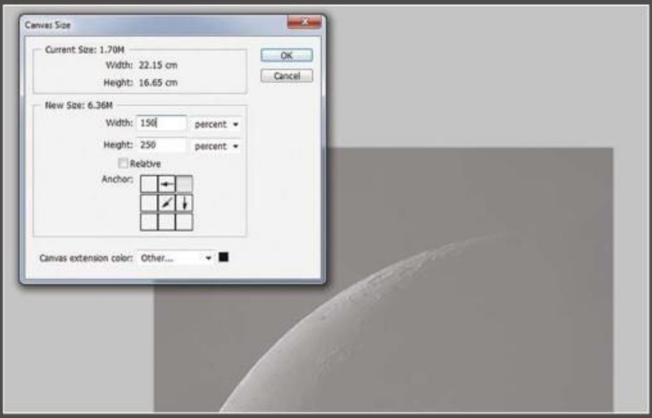
STEP 2

Move up and down the crescent, adjusting your camera's exposure and gain to achieve 80-90 per cent peak levels for the brightest surface. Position with one crescent cusp close to the edge of the frame and capture 500-800 frames. Move for the next capture, making sure there's plenty of overlap. Repeat for the entire crescent.



STEP 3

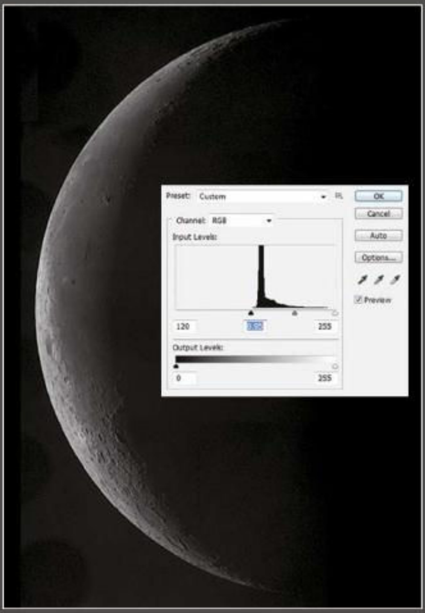
Process each overlapping sequence in RegiStax, Autostakkert! or AviStack. One useful tip is to process without wavelet sharpening, saving the result as a PNG or FITS file. Make a copy and wavelet sharpen individually using RegiStax. If you mess up (too much looks unnatural), start again from the original.



Current Size: 1.70M
Width: 22.15 cm
Height: 16.65 cm
New Size: 6.36M
Width: 150 percent
Height: 250 percent
☐ Relative
Canvas extension color: Other...

STEP 4

Open one of the finished frames in a layer-based graphics program and crop off any white borders. Increase canvas size to incorporate the entire mosaic; it's fine to guess as you can alter the size later. Load a new frame as a separate graphic, select the image (ignoring any white borders) and copy to the clipboard.



Preset: Custom
Channel: RGB
Input Levels: 120 255
Output Levels: 0 255
☑ Preview

STEP 5

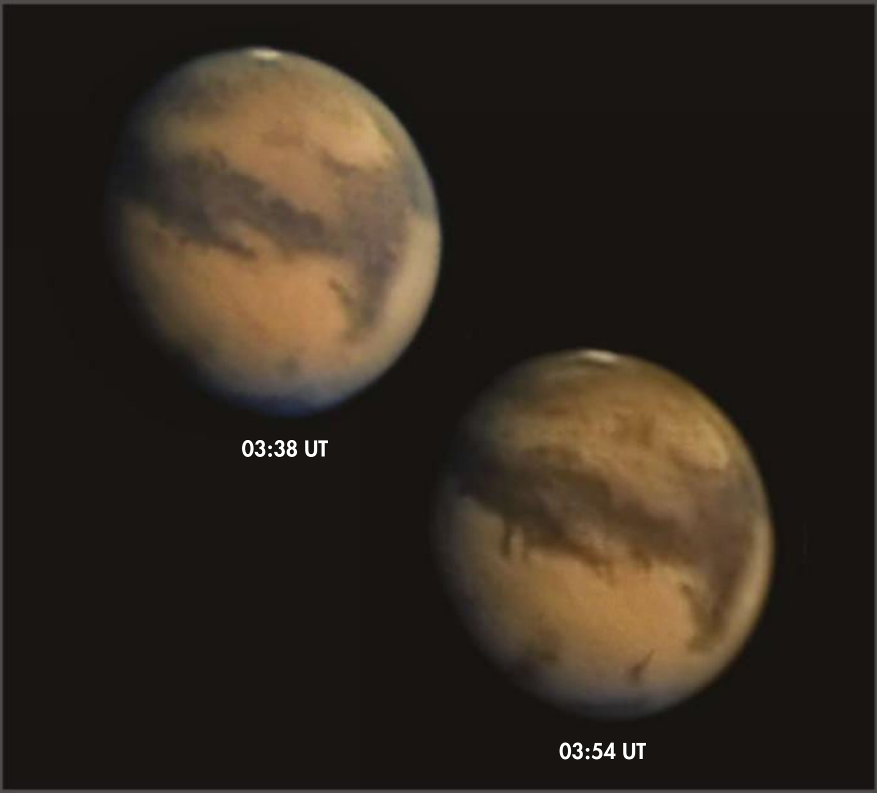
Paste the image you copied into the first image as a new top layer. Move it until it lines up with the lower image. Toggle visibility and use the cursor keys to nudge its position. If necessary, tweak its brightness to get a close tonal match. Use a 10 per cent eraser to rub out sharp overlap edges. Repeat until the entire mosaic is complete. Flatten the layers, then tweak the levels to make the sky dark.

STEP 6

The effects of photographing with a bright morning twilight around the Moon can be mitigated to an extent by fitting a red or infrared-pass filter to the front of a monochrome high frame rate camera. This causes the blue sky to darken, so improving the contrast of the crescent.

PLANETS & COMETS

Taking their name from the ancient Greek word for 'wandering star,' humanity has always seen planets as something a little different in the night sky, orbiting the Sun as the Earth does. Massive enough to become round under the influence of gravity, but not so big as to erupt into a star, planets must have cleared their orbits of other bodies to earn the title. Comets are the true wanderers of the Solar System. Not as often seen with the naked eye as planets, these collections of ice and rubble can travel on huge orbits and were once regarded as portents of doom in the skies. With their streaming tails of gas, they make a fine target for amateur astronomers or astrophotographers.



▲ MARS

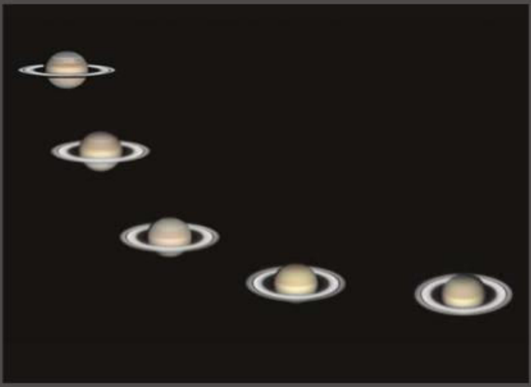
DAVE HUNTER, YORK, 24 SEPTEMBER 2005

Dave says: "The telescope I used was homemade. Seeing was variable, between two and five out of 10 on the Pickering scale, but it was perfectly clear. Conditions were very still and the temperature was a cold 3°C."

Equipment: Atik 1HS camera, 10-inch f/9.4 Newtonian telescope with Orion Optics parts, Televue 3x Barlow lens

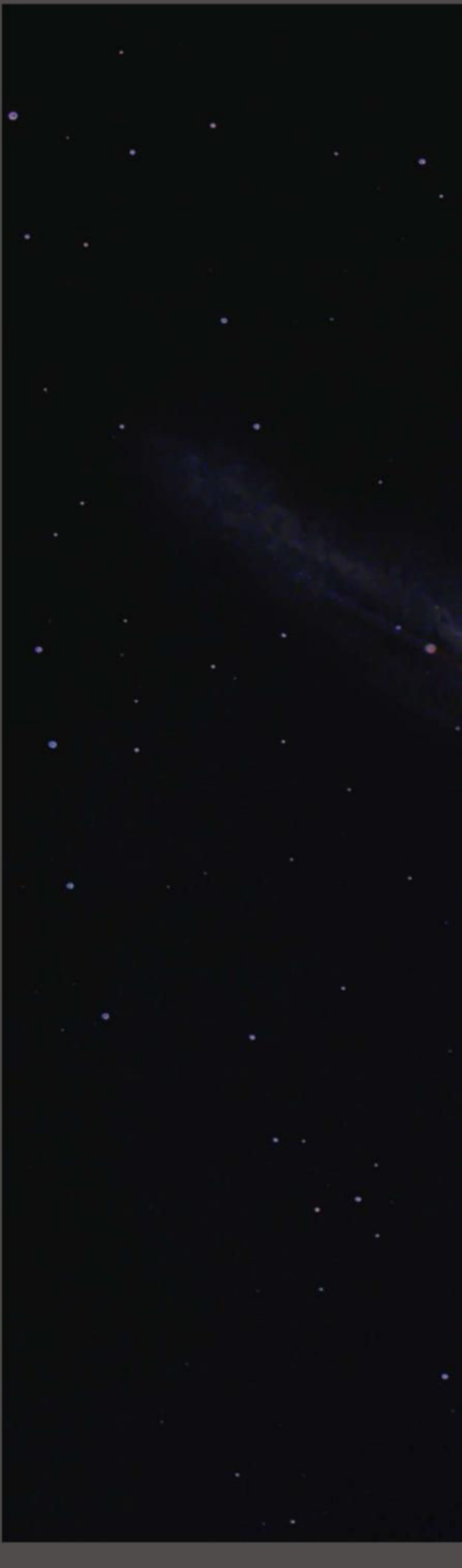
▼ FIVE YEARS OF SATURN

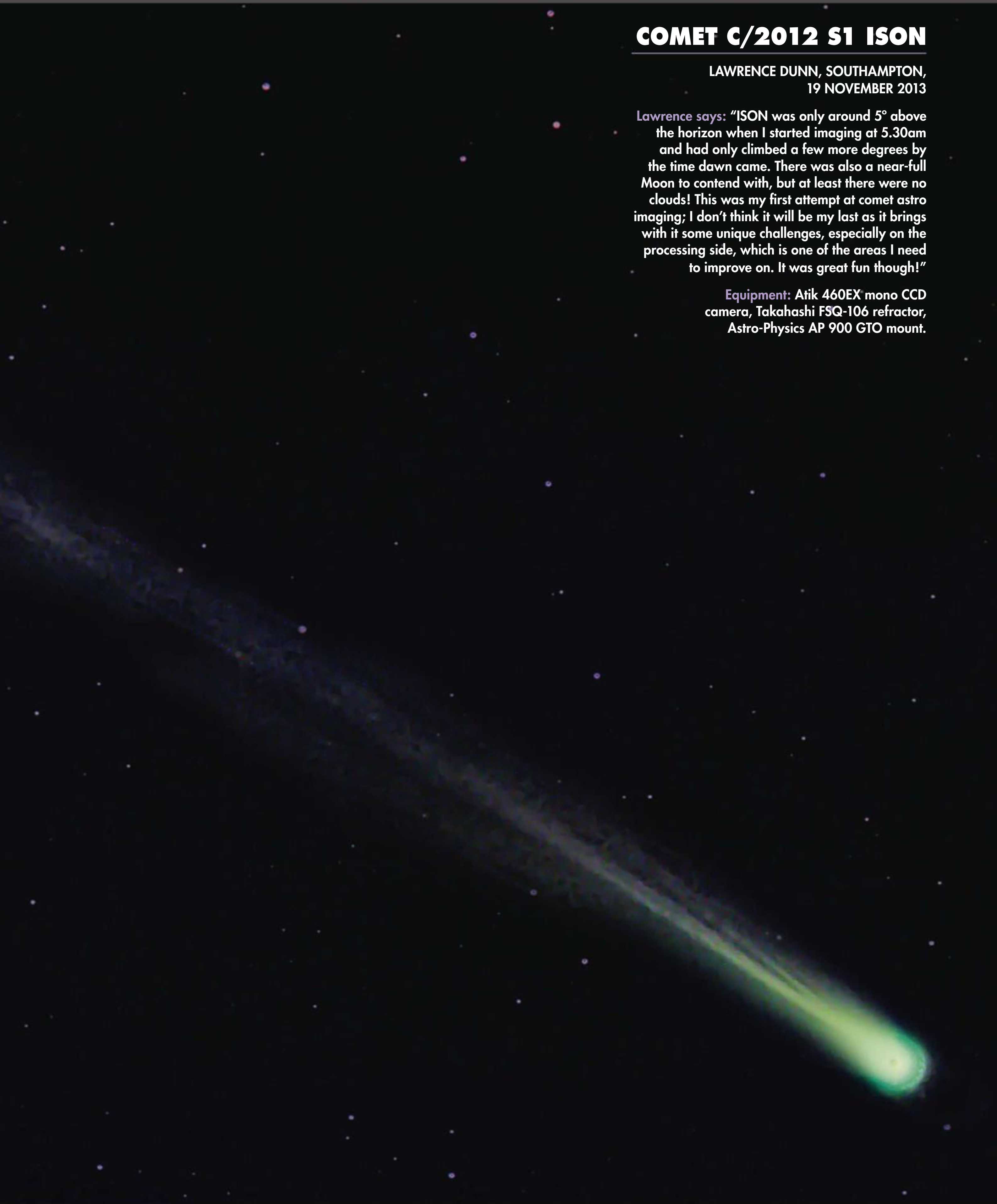
TOM HOWARD, SUSSEX, TAKEN OVER FIVE YEARS ENDING 15 APRIL 2015



Tom says: "As well as showing Saturn's increasing tilt from Earth's point of view between 2011 (top left) and 2015 (bottom right), this compilation also documents my progress in planetary imaging during these five apparitions using a variety of telescopes, cameras and imaging techniques."

Equipment: Celestron Skyris 618C CCD camera, Celestron C11 Schmidt-Cassegrain telescope, EQ6 mount.



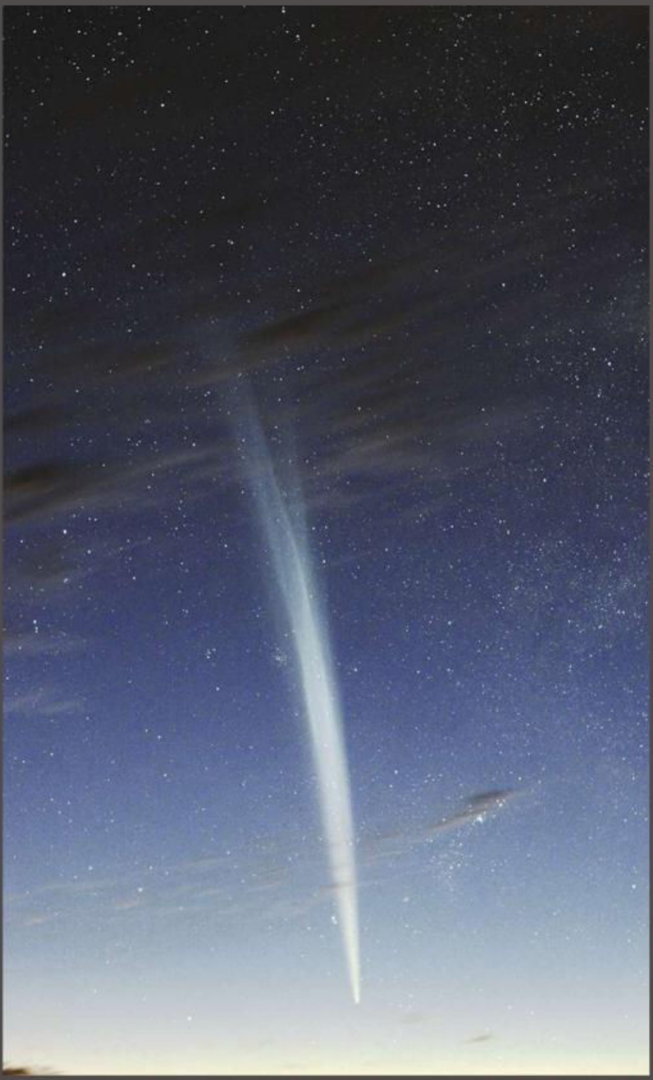


COMET C/2012 S1 ISON

LAWRENCE DUNN, SOUTHAMPTON, 19 NOVEMBER 2013

Lawrence says: "ISON was only around 5° above the horizon when I started imaging at 5.30am and had only climbed a few more degrees by the time dawn came. There was also a near-full Moon to contend with, but at least there were no clouds! This was my first attempt at comet astro imaging; I don't think it will be my last as it brings with it some unique challenges, especially on the processing side, which is one of the areas I need to improve on. It was great fun though!"

Equipment: Atik 460EX mono CCD camera, Takahashi FSQ-106 refractor, Astro-Physics AP 900 GTO mount.

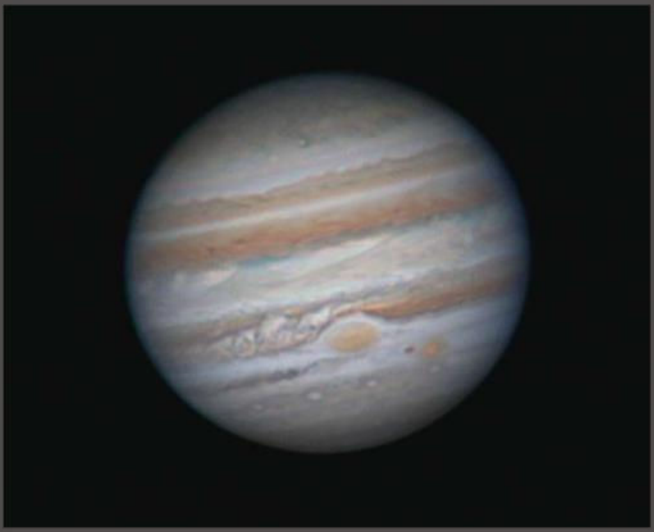


◀ COMET LOVEJOY

LESTER BARNES, PORT LINCOLN, SOUTH AUSTRALIA, 23 DECEMBER 2011

Lester says: "This is the second brightest comet I've seen in 45 years of interest in the night sky. The comet grew from a length of 15° on 23 December to 30° on 30 December."

Equipment: Canon 20Da DSLR camera, tracking mount.



▲ JUPITER

JIM THURSTON, LONDON, 19 NOVEMBER 2012

Jim says: "This was taken from my observatory on an evening that started poorly but got better after the stroke of midnight."

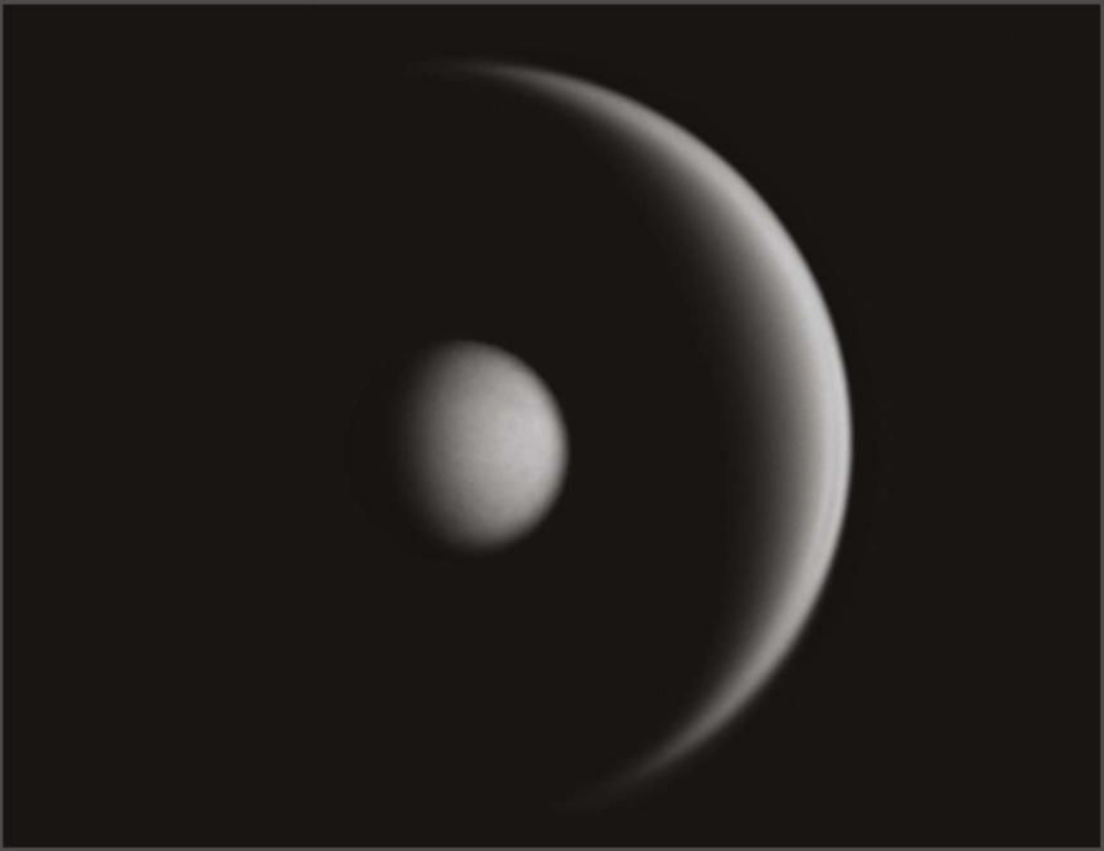
Equipment: Imaging Source DMK 21AU618.AS CCD camera, Celestron 9.25-inch Schmidt-Cassegrain telescope, Astronomik RGB filters.

VENUS'S CHANGING SIZE ▶

DAVE GRADWELL, NEAR BIRR, IRELAND, 15 MARCH AND 23 JULY 2007

Dave says: "This image shows just how big Venus became over 2007. The smaller Venus was taken on 15 March when the disc size was only 12 arcseconds, while the larger image was taken on 23 July when the disc was a whopping 44 arcseconds."

Equipment: Lumenera SkyNyx 2-0 CCD camera, Celestron CG-11 telescope.

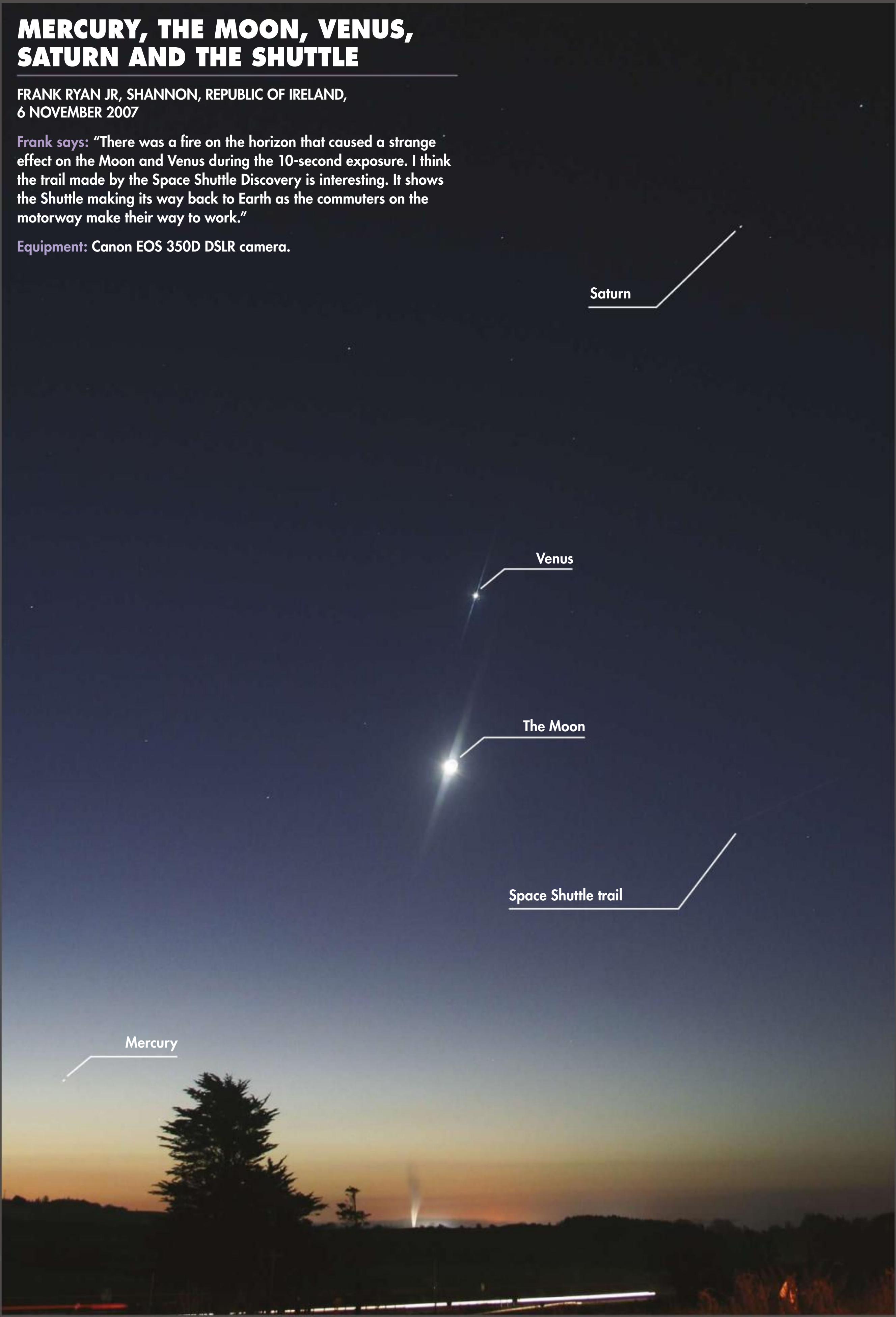


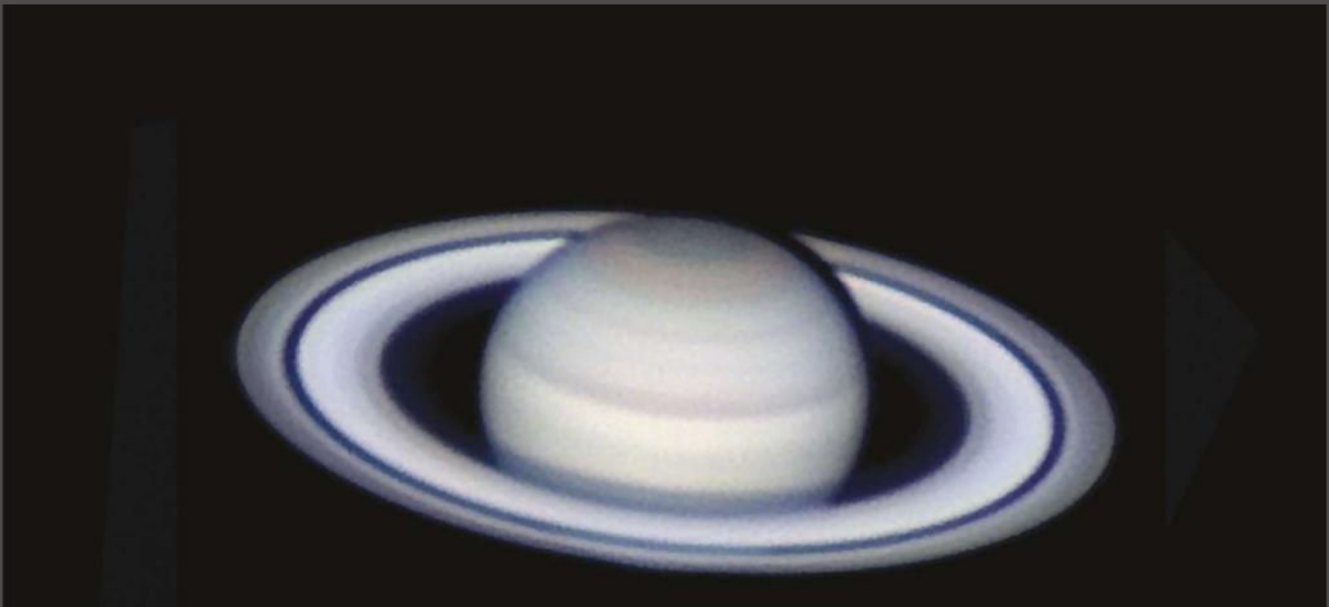
MERCURY, THE MOON, VENUS, SATURN AND THE SHUTTLE

FRANK RYAN JR, SHANNON, REPUBLIC OF IRELAND,
6 NOVEMBER 2007

Frank says: "There was a fire on the horizon that caused a strange effect on the Moon and Venus during the 10-second exposure. I think the trail made by the Space Shuttle Discovery is interesting. It shows the Shuttle making its way back to Earth as the commuters on the motorway make their way to work."

Equipment: Canon EOS 350D DSLR camera.





SATURN

JAMIE COOPER, NORTHAMPTON, NORTHAMPTONSHIRE, 7 FEBRUARY 2005

Jamie says: "The image was taken using R, G and B filters to create a true colour image. Frames were stacked using Registax and the image further processed with Photoshop."

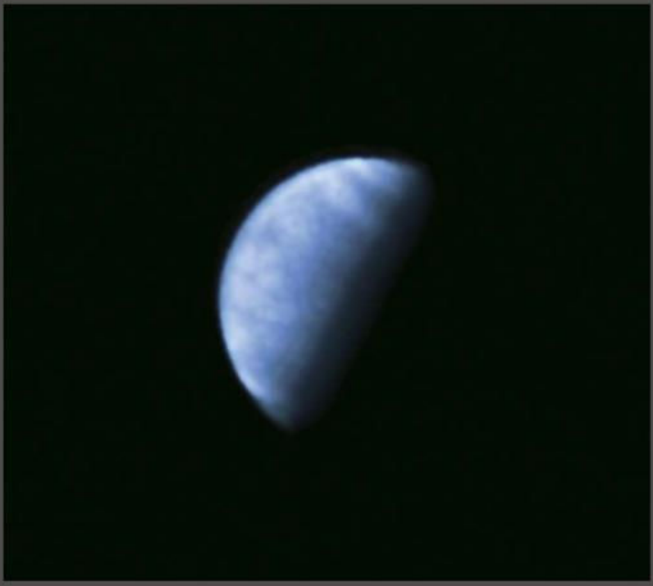
Equipment: Atik 1-HS camera, Orion Optics 10-inch SPX Newtonian.

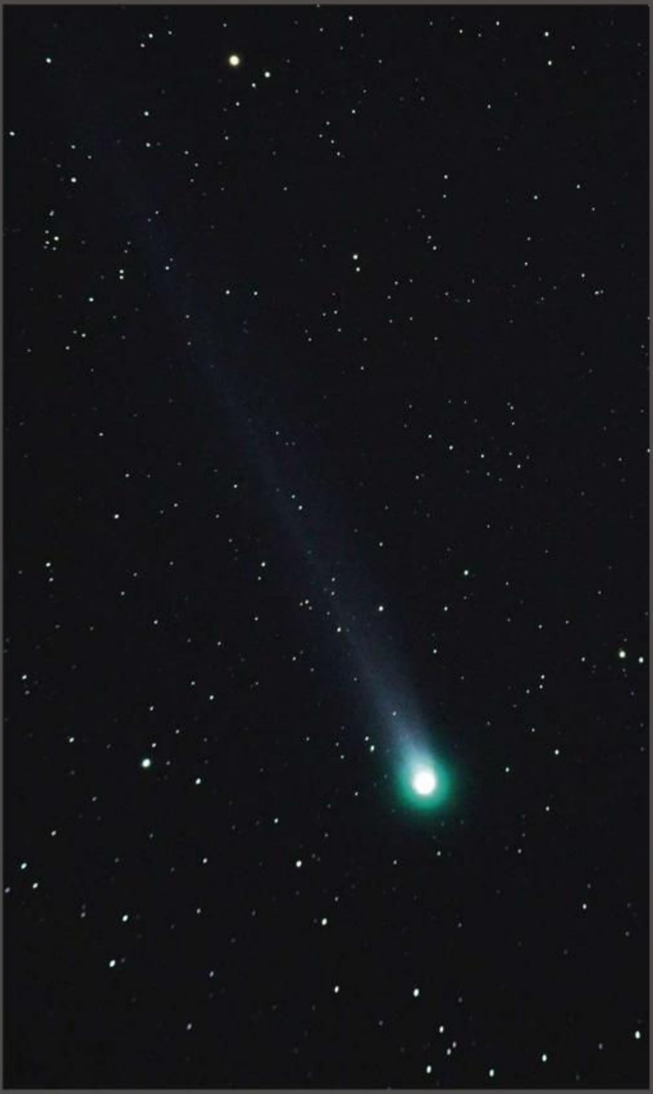
▼ VENUS

BRUCE KINGSLEY, BARBADOS, 15 APRIL 2006

Bruce says: "I have always wanted to see the clouds of Venus. This picture was taken during an astronomy holiday to Barbados, where conditions for planetary imaging were superb."

Equipment: Atik 1HS CCD camera, Celestron C11 telescope and an ultraviolet filter.



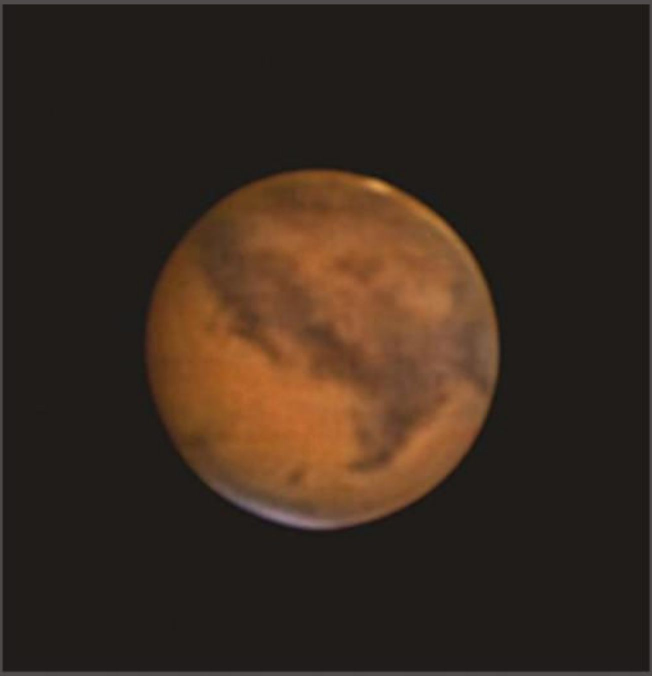


◀ COMET C/2013 R1 LOVEJOY

JAMES COARD, COUNTY DOWN, 4 DECEMBER 2013

James says: "I initially overlooked Comet Lovejoy due to the hype over ISON. When I did image it, I was amazed by how beautiful it was."

Equipment: Canon EOS 5D Mk III DSLR camera, 3-inch ED refractor.



▲ MARS

ANTONIS PANTELIDIS, FLORINA, GREECE, 25 OCTOBER 2005

Antonis says: "A lot of identifiable details on Mars's surface are clearly visible, like the Syrtis Major region and the blue hue of the north pole, which is at the bottom because this image is upside-down."

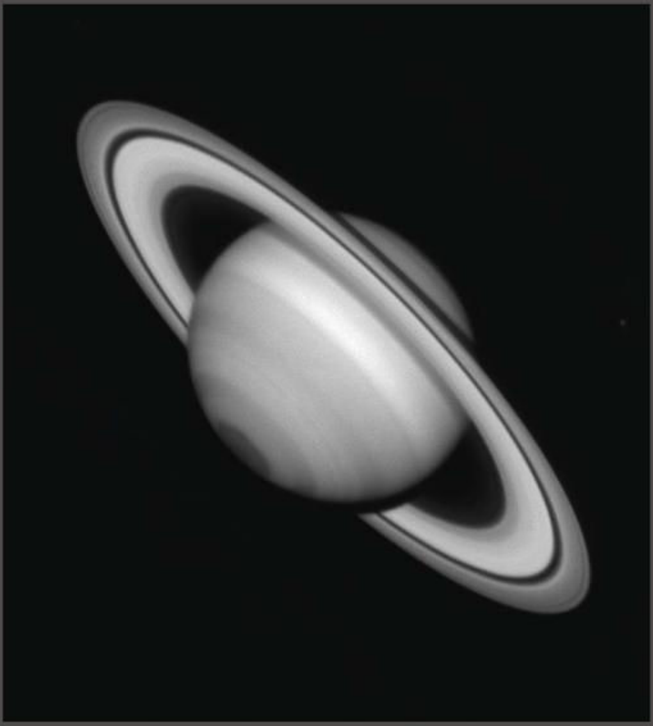
Equipment: Philips Toucam Pro 840 webcam, Takahashi Mewlon 210mm reflector with Televue 2x Barlow lens.

▼ SATURN

MARC DELCROIX , PIC DU MIDI, FRANCE, 30 JUNE 2013

Marc says: "The view through the eyepiece at 1,000x was magnificent and magic, with the rings splendidly detailed."

Equipment: ZWO ASI120MM CCD camera, 106cm telescope at Pic du Midi Observatory.

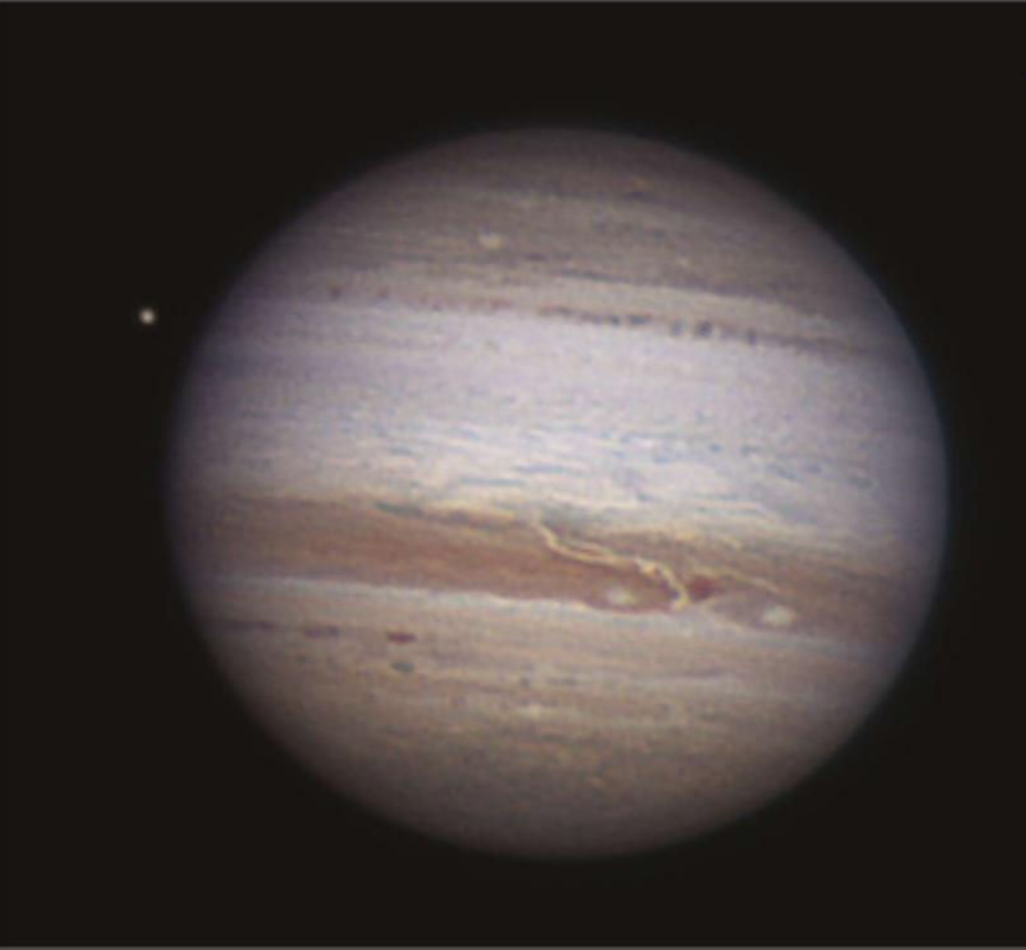


JUPITER

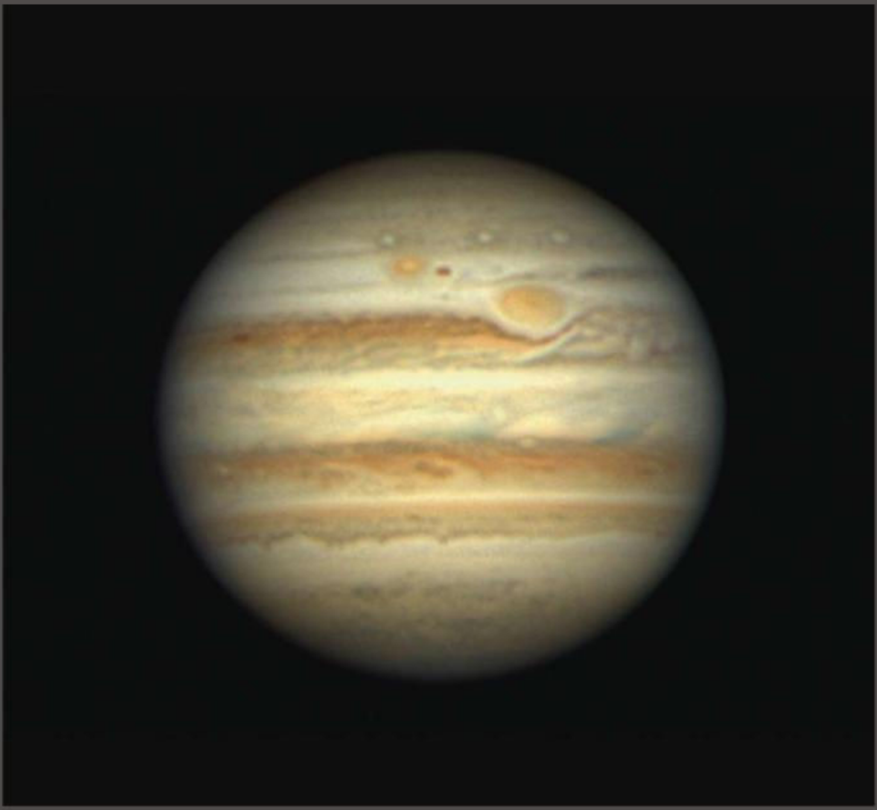
TROY TRANTER, KURRI KURRI, AUSTRALIA, 11 SEPTEMBER 2010

Troy says: "I like the detail and colour captured on Jupiter. Some of the planet's fine detail like the festoons, South Equatorial Belt and white ovals really look great. This is also the first time I have been able to capture Europa this well."

Equipment: SKYnyx 2-0m CCD camera, Celestron C9.25 9.25-inch Schmidt-Cassegrain telescope.



PLANETS & COMETS



◀ JUPITER

DENNIS BOON, SUFFOLK,
23 NOVEMBER 2012

Dennis says: "The first clear night for a couple of weeks and with Jupiter nearing opposition it was a great opportunity for some imaging. I particularly like this shot, showing the Great Red Spot and Red Spot Junior. They were well placed and the equatorial belts showed lots of detail as well."

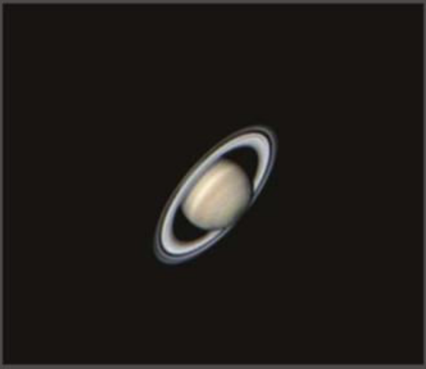
Equipment: Imaging Source DFK 21AU618.AS CCD camera, Orion Optics OMC200 Maksutov-Cassegrain telescope, TeleVue 2x Powermate.

SATURN ▶

RONALD PIACENTI JUNIOR, BRAZIL,
6 DECEMBER 2015

Ronald says: "I was surprised at how easy it was to capture this image. It was the first time I'd used this telescope for planetary imaging, but in the end I was very happy."

Equipment: ZWO ASI120MC monochrome camera, GSO 2x Barlow lens, Celestron C6 XLT Schmidt-Cassegrain, Sky-Watcher HEQ5 Pro SynScan mount.



▲ MARS

ED SAMPSON AND TREVOR LITTLE, WEST SUSSEX, 1 FEBRUARY 2008

Ed says: "We love Mars because of the detail a simple webcam can pull from the planet. It was months past its best and only about 11 arcseconds in diameter."

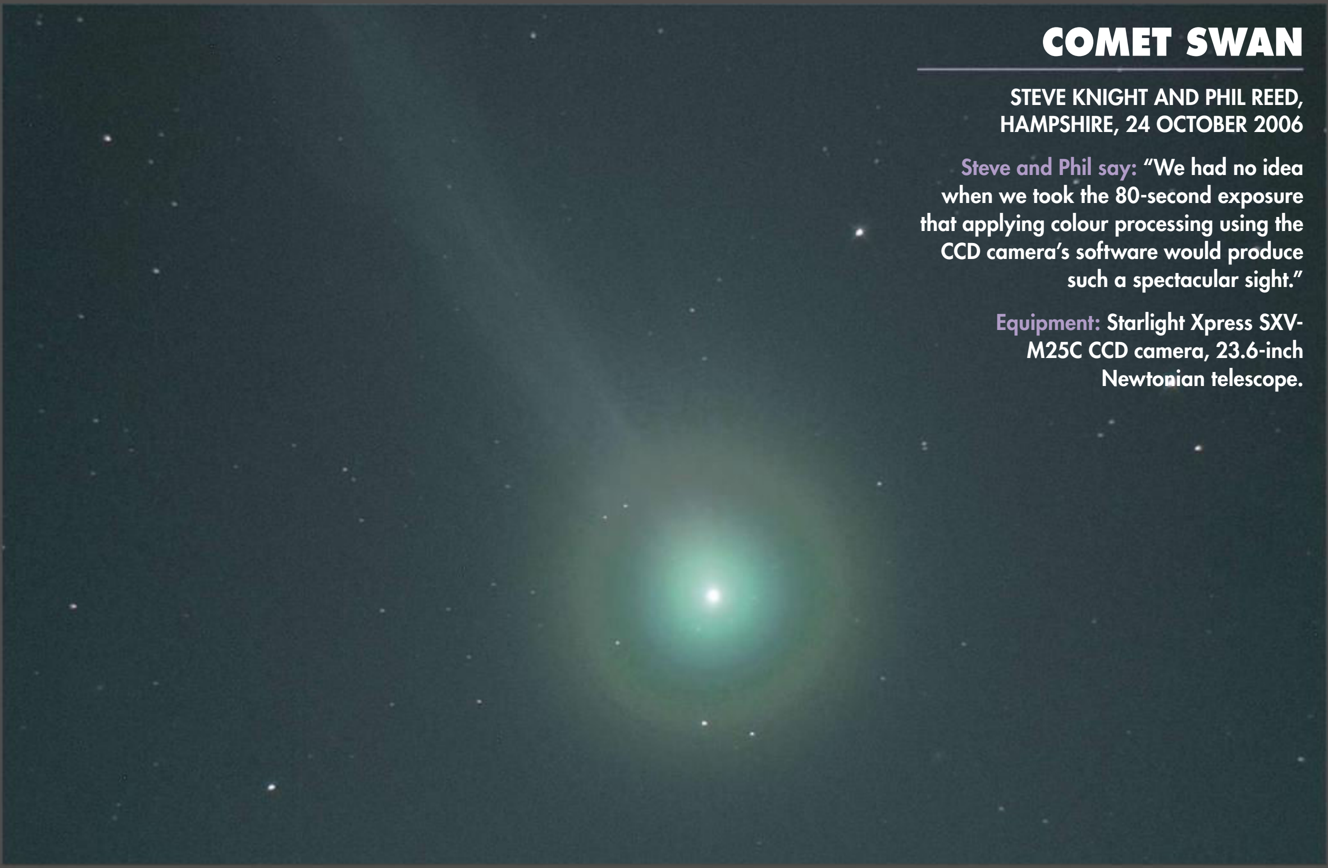
Equipment: Monochrome Toucam webcam, 15-inch reflector, Astronomik RGB filters and an Astronomik IR filter.

◀ COMET 17P/ HOLMES

PER-MAGNUS HEDÉN, VALLENTUNA, SWEDEN,
7 NOVEMBER 2007

Per-Magnus says: "I woke up in the middle of the night so I could photograph Comet Holmes. Despite light pollution I managed to capture some of the tail, mostly in the blue channel."

Equipment: Canon EOS 350D DSLR camera, Orion 80ED refractor, NexStar 11 mount, IDAS LPS filter.

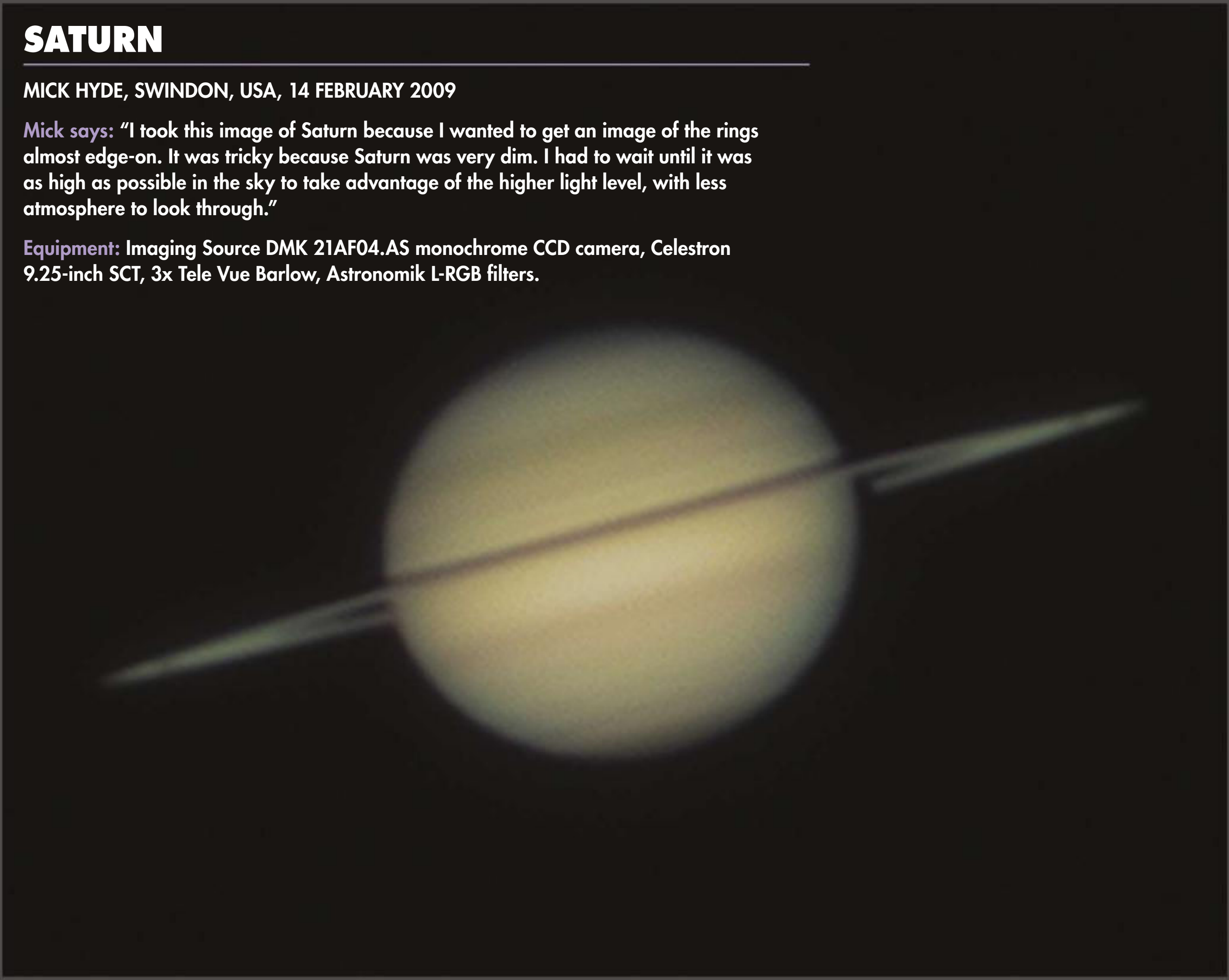


COMET SWAN

STEVE KNIGHT AND PHIL REED, HAMPSHIRE, 24 OCTOBER 2006

Steve and Phil say: "We had no idea when we took the 80-second exposure that applying colour processing using the CCD camera's software would produce such a spectacular sight."

Equipment: Starlight Xpress SXV-M25C CCD camera, 23.6-inch Newtonian telescope.



SATURN

MICK HYDE, SWINDON, USA, 14 FEBRUARY 2009

Mick says: "I took this image of Saturn because I wanted to get an image of the rings almost edge-on. It was tricky because Saturn was very dim. I had to wait until it was as high as possible in the sky to take advantage of the higher light level, with less atmosphere to look through."

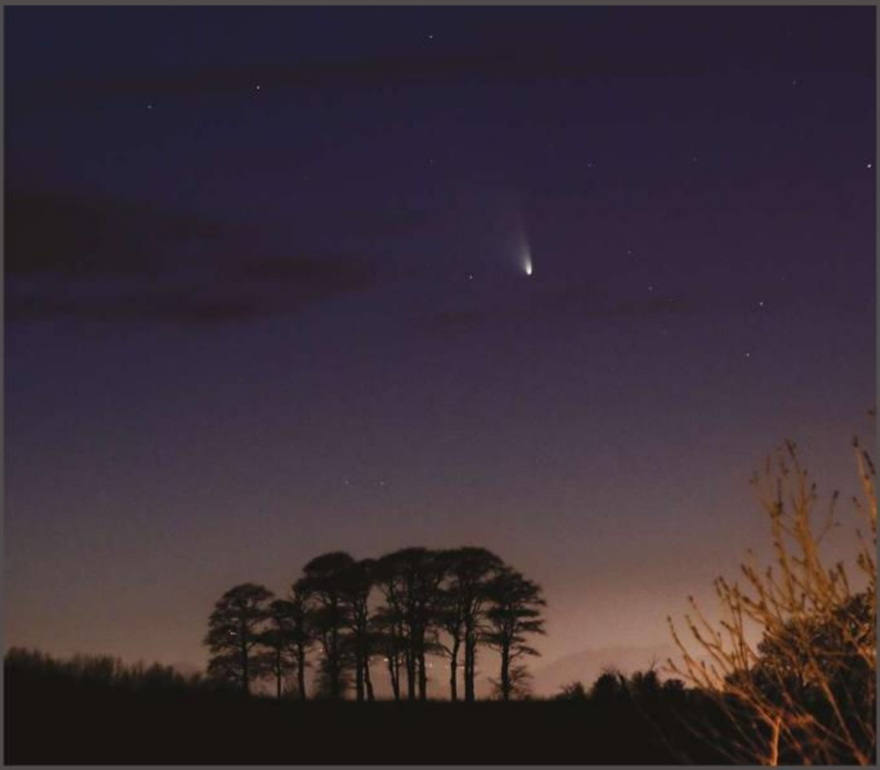
Equipment: Imaging Source DMK 21AF04.AS monochrome CCD camera, Celestron 9.25-inch SCT, 3x Tele Vue Barlow, Astronomik L-RGB filters.

COMET C/2011 L4 PANSTARRS ▶

KEN FUNNELL, BISHOP'S TAWTON, DEVON
18 MARCH 2013

Ken says: "I had a very satisfying evening viewing Comet C/2011 L4 PANSTARRS with binoculars; I rounded it off with this lovely shot of the comet as it was setting."

Equipment: Canon EOS 350D DSLR camera, Tamron 28-300mm lens at 119mm.

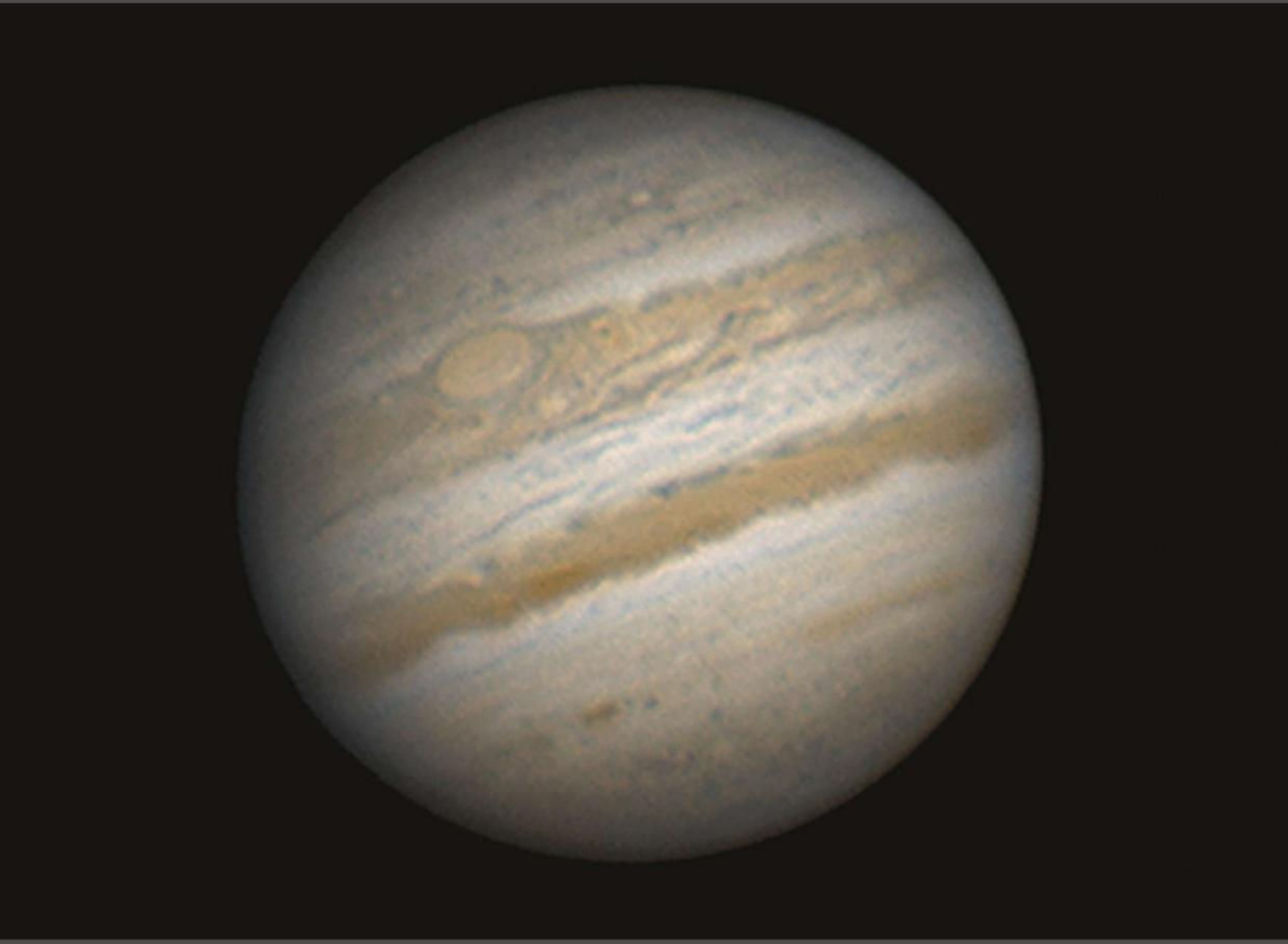


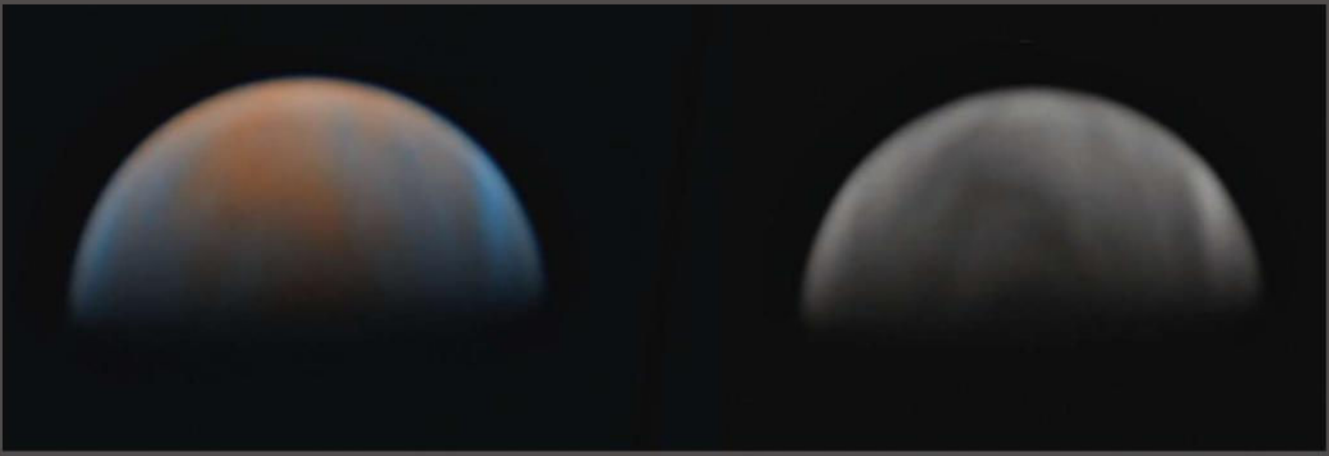
▼ JUPITER

SIMON KIDD, WELWYN, 11 JULY 2011

Simon says: "It was great to see the development of the Southern Equatorial Belt back to something approaching 'normal', after its disappearance the year before."

Equipment: Point Grey Flea 3 CCD camera, Celestron 14-inch Schmidt-Cassegrain telescope.





▲ VENUSIAN CLOUDS

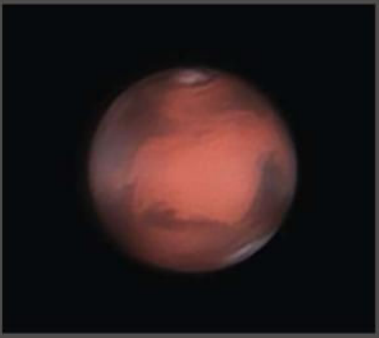
NEIL PHILLIPS, ESSEX, 11 MARCH 2012

Neil says: "I particularly like the image because the cloud structure is quite complex, and the good seeing on the evening in question captured this very well."

Equipment: Imaging Source DMK 21AU618.AS CCD camera, 245mm Newtonian reflector, NEQ6 mount, Antares 3x Barlow lens, Astronomik ProPlanet IR 742 and Astrodon UV-Venus filters.

▼ MARS

TONY KING, WOKING, 15 APRIL 2014



Tony says: "I bought this telescope secondhand; this is my first Mars image with it. There is always a lot to learn with new kit, but I'm really pleased with the level of detail."

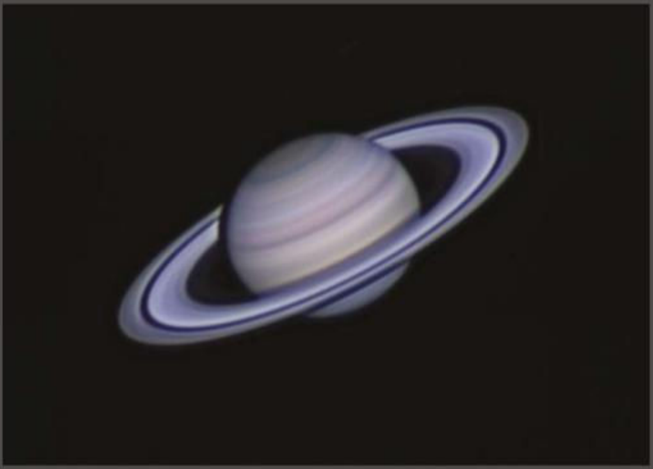
Equipment: ZWO ASI120MM CCD camera, Celestron C11 telescope, Sky-Watcher NEQ6 Pro mount.

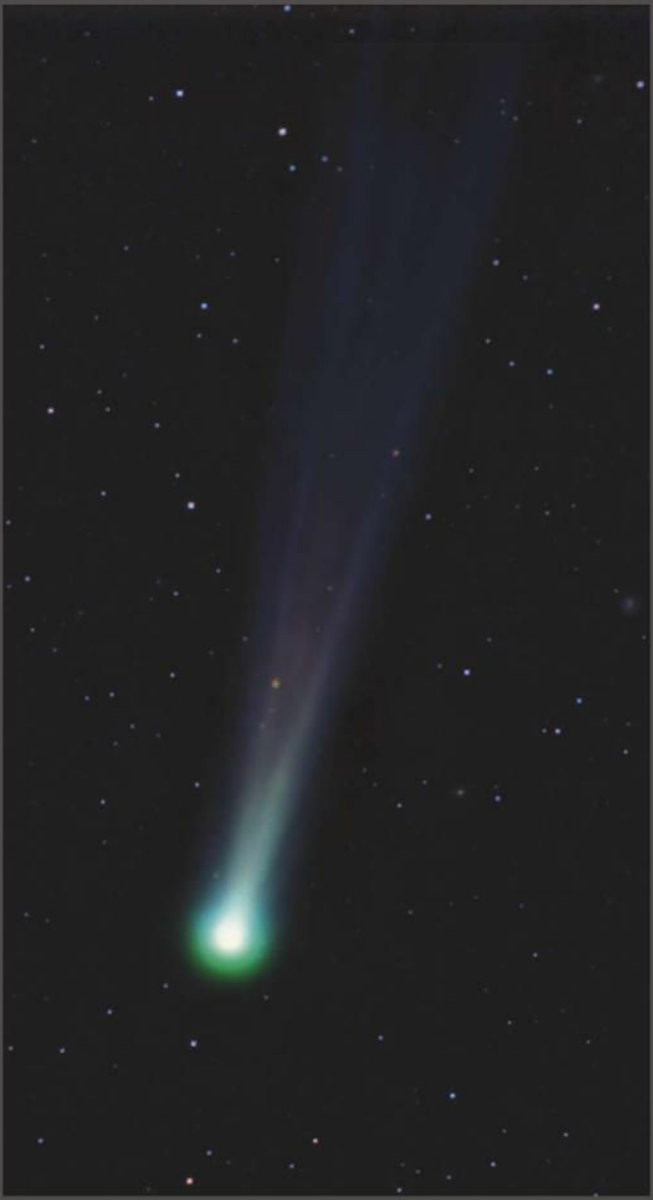
▼ SATURN

IAN SHARP, HAM, WEST SUSSEX, 20 DECEMBER 2005

Ian says: "The conditions were superb that night: the best visual view of Saturn I've ever had in 35 years of telescopic observations."

Equipment: Atik 1HS CCD camera, Celestron C-11 telescope.



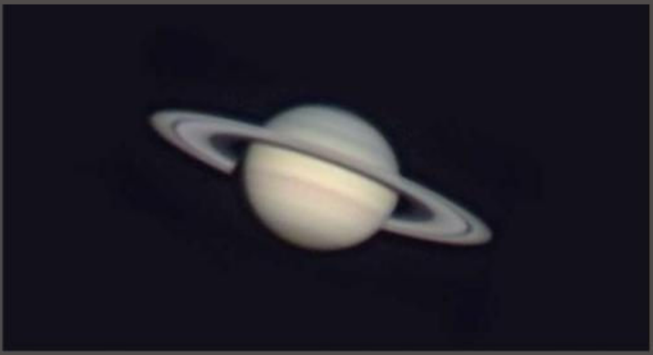


▲ COMET C/2012 S1 ISON

SIMON WILSON, BAKEWELL, 15 NOVEMBER 2013

Simon says: "I was pleased to capture the beautiful green colour of the coma set against a nice star field, with a few faint fuzzies for good measure."

Equipment: Atik 460EX CCD camera, Takahashi FSQ85 refractor, Sky-Watcher NEQ6 mount.



▲ SATURN

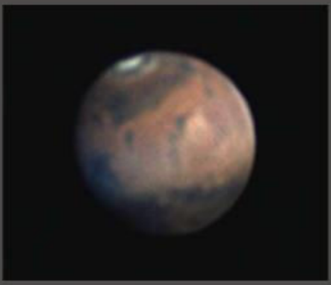
DAVE THOMPSON, CONSETT, COUNTY DURHAM, 13 APRIL 2008

Dave says: "I liked this image because it was my best capture of Saturn this apparition, and it was a bit of a triumph after many nights of poor seeing conditions. I also felt that the colours were quite natural-looking for an RGB capture."

Equipment: Imaging Source DMK 21AU04 CCD camera, Celestron C11, Sky-Watcher EQ6 SkyScan mount.

▼ MARS

JON BUNTING, NORFOLK, 7 APRIL 2012



Jon says: "The thing I like most about imaging Mars is that you are looking at the planetary surface. It makes a change from the clouds of Jupiter, Saturn and Venus."

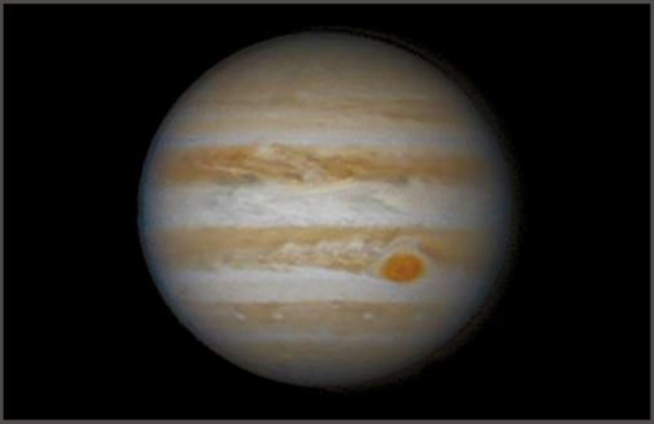
Equipment: Imaging Source DMK 21AU618.AS CCD camera, Tal 200K Klevzov-Cassegrain telescope, 3x Barlow lens.

▼ JUPITER

PAUL WILLIAMSON, ABU DHABI, 28 DECEMBER 2015

Paul says: "I borrowed a friend's C11 to see first hand the difference the aperture makes, as I own a C8. I was so impressed that I have already upgraded."

Equipment: Imaging Source DMK 21AUG618 USB 2.0 monochrome industrial camera, Celestron C11-A XLT (CGE) optical tube, Tele Vue 2.5x Powermate, Baader RGB filters.

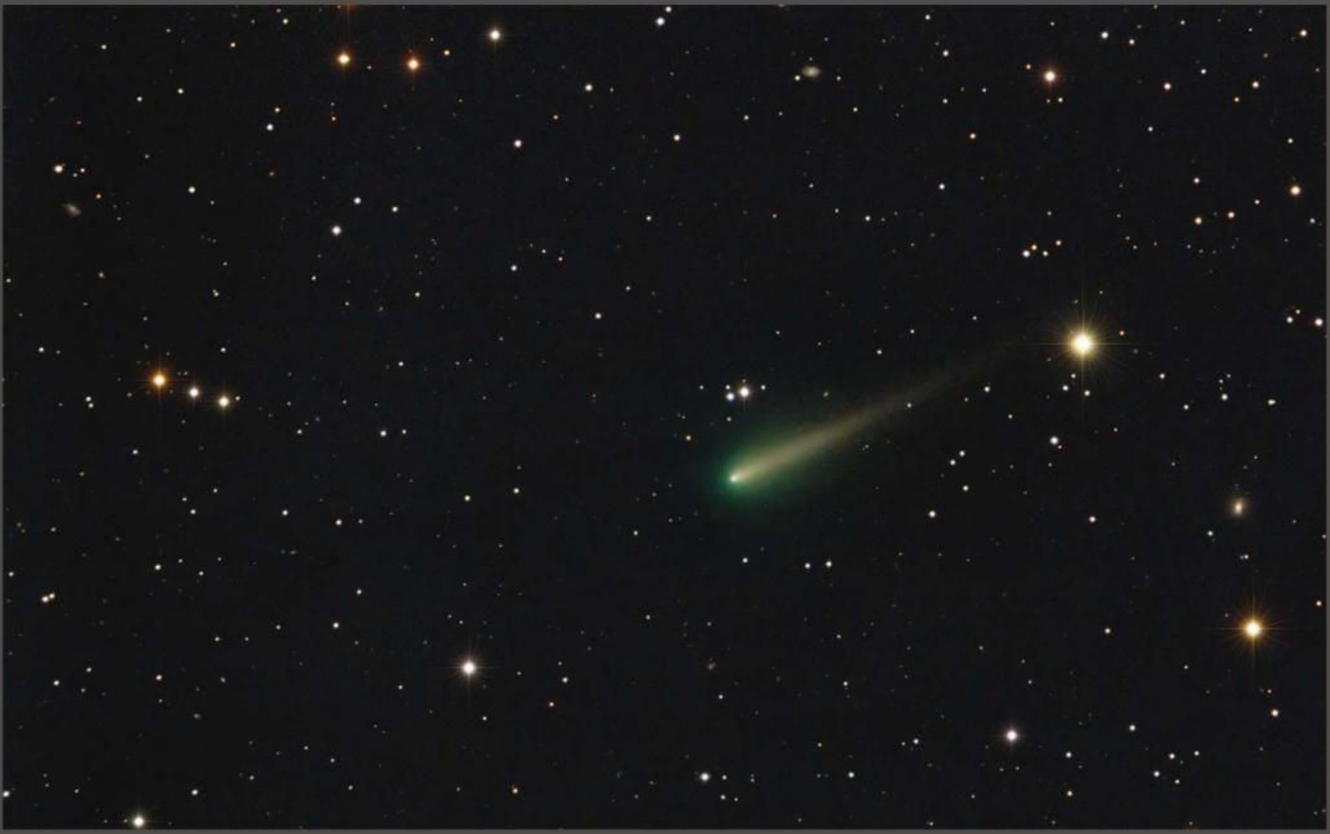


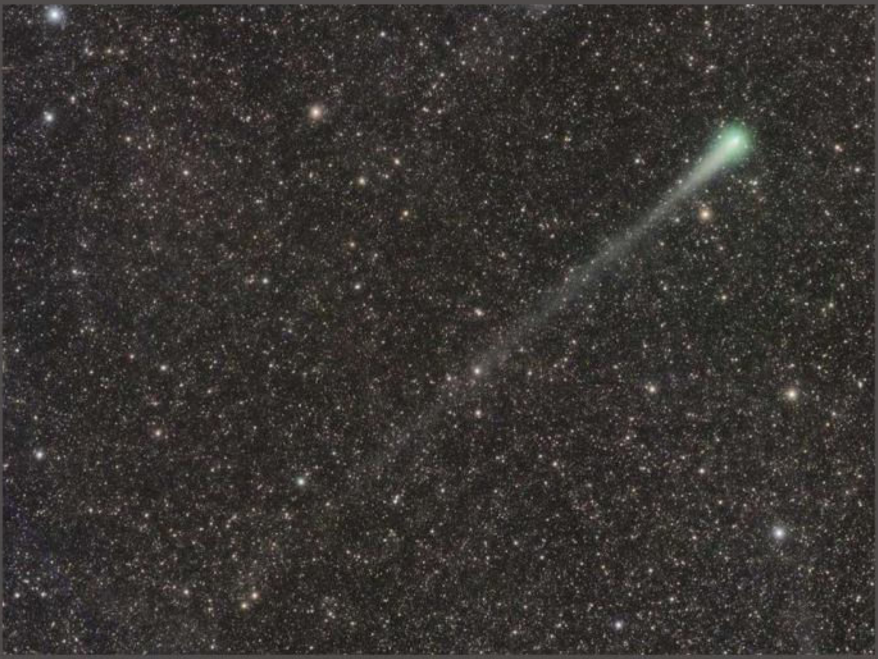
▼ COMET C/2012 S1 ISON

CLIFFORD SPOHN & TERRY HANCOCK, OHIO, USA, 11 OCTOBER 2013

Terry says: "On the morning of 11 October my good friend Clifford and I captured ISON as it made its way through the constellation of Leo, very low in the sky. Quite a few very small galaxies can also be seen in this image, see how many of these tiny fuzzies you can count! Credit goes to Cliff for capturing the comet, while I did the calibration, stacking and post-processing."

Equipment: QHY9 mono CCD camera, TEC APO140ED f/7 refractor, Paramount ME German equatorial mount.





▲ COMET C/2013 US10 CATALINA

JOSÉ J CHAMBÓ BRIS, 1 OCTOBER 2015, SIDING SPRING, AUSTRALIA

José says:"This was the last photo I took in the southern hemisphere before the comet disappeared from view. In this wide-field image you can see a greenish coma due to gas emission of diatomic carbon between the constellations of Centaurus and Lupus."

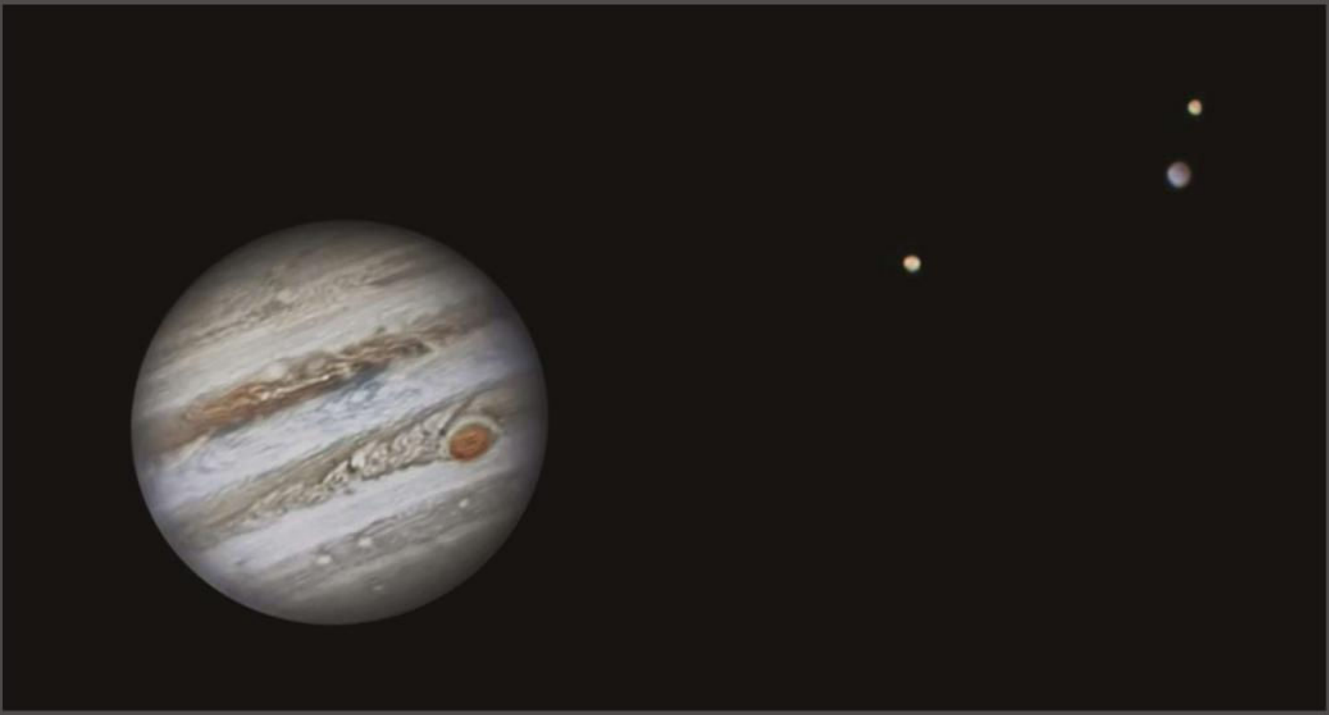
Equipment: FLI MicroLine ML16803 monochrome CCD camera, Takahashi FSQ-106ED f/5.0 apo refractor.

▼ JUPITER AND ITS MOONS

JOHN SHORT, TYNE AND WEAR,
22 NOVEMBER 2014

John says: "This image shows Jupiter and three of its moons and was taken with a DSLR camera."

Equipment: Canon EOS 6D DSLR camera, Celestron 8SE telescope.



▲ JUPITER, IO, EUROPA AND GANYMEDE

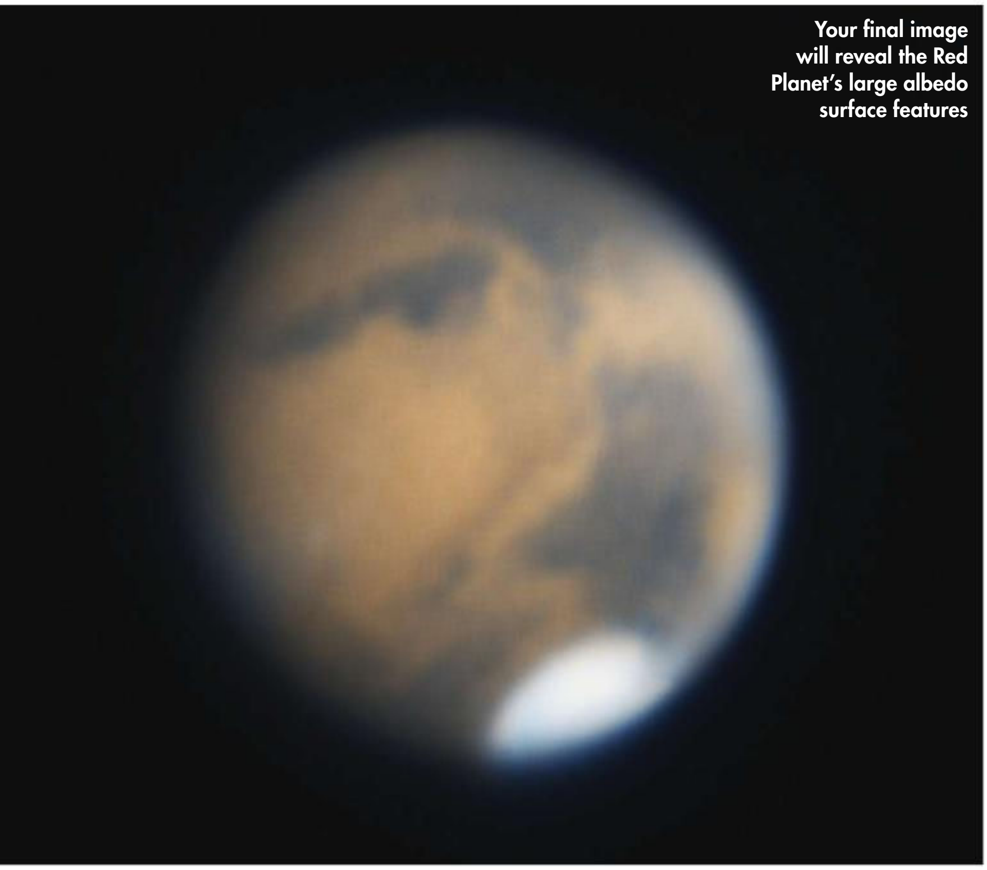
HARVEY SCOOT, ESSEX, 1 JANUARY 2016

Harvey says: "The image was taken at 5.10am on New Year's Day from my Essex-based observatory. I got a visual of Jupiter at around 100x magnification and studied how much detail could be observed on the disc itself. It was then that I realised that this particular night was quite special and actually better than I had originally thought. I am extremely pleased with how it turned out, especially as Jupiter was not at opposition at this time. I only hope that we get similar conditions when it is!"

Equipment: ZWO ASI224MC USB 3.0 cooled colour CMOS camera, Celestron Edge HD Schmidt-Cassegrain telescope.

WORDS: PETE LAWRENCE

IMAGING MARS AT OPPOSITION



Your final image will reveal the Red Planet's large albedo surface features

RECOMMENDED EQUIPMENT

8-inch or larger scope, Barlow lens, monochrome high frame rate camera, RGB imaging filters mounted in a filter wheel

Mars is a bit of a tease as far as practical astronomy is concerned. After lurking in tricky parts of the sky and looking rather diminutive for many months, it bursts back onto the scene for a short period, before fading into the background once again.

Opposition is the best time to both observe and image Mars, a position it reached in May 2016 and will return to in July 2018. Here, we'll look at how to image the planet with a mono high frame rate camera and a set of RGB imaging filters.

Mars is the closest world we can see that has reasonable similarity to Earth, in that it shows both surface features and weather. From Earth we can see brighter deserts, darker rock and gleaming polar caps. These are 'albedo features'; they are visible because they have notably different reflectivity (albedo) to adjacent areas.

Features such as craters, mountains and valleys are much harder to image from Earth because of their small apparent size at the planet's vast distance. Known as 'relief' features, these would normally be revealed because height variation causes them to cast shadows, just like elevated structures close to the terminator do on the Moon. From Earth, the Martian shadows are tiny and hard to pick out, so the main features of interest for Mars imagers are albedo based rather than relief.

Using a mono high frame rate camera and RGB filters, Mars's reflectivity becomes quite interesting – the reason for this is that the 'information' that passes through a green filter gives very little extra image detail than can be obtained with red and blue filters alone. This surprising fact can be used to help overcome one of the main issues when RGB imaging a relatively fast rotating planet such as Mars: if you take too long to collect an image set, the final RGB may show motion blur. For this reason, you need to try and complete the entire capture sequence in less than five minutes. For a colour camera this isn't too hard, but when trying to capture images using several filters it is more of a concern.

Process your greens

Advanced processing techniques such as derotation can be used to address motion blur, but there's an easier solution that hinges on the lack of significant detail visible in the green filter – simply abstain from taking a green-filtered image in the first place. It may sound crazy, but the green image can be artificially synthesised from the red and blue results. The final colour image will look almost identical to what you would have achieved using a full set of RGB images, but you'll reduce the time it needed for your capture sequence by a third.

Generating a synthetic green image also streamlines the capture process, allowing you to generate a smooth sequence of Mars images for animation purposes. For example, a run of RBRBRB captures would allow you to create an R(G)B result using the first RB pair – the parentheses indicate that the green is synthetic – then a second B(G)R result using the first BR pair. A third R(G)B result would be created using the second RB pair, and so on. With a fairly short time gap between R(G)B results, these can be animated together to produce a smooth flowing rotation sequence of this fascinating world.

KEY TECHNIQUE

Although colour cameras are catching up, mono cameras still have the edge when it comes to planetary imaging. For a full-colour result from a mono camera you need red, green and blue imaging filters; this significantly reduces colour-related problems such as chromatic aberration and atmospheric dispersion. Unfortunately, filtered sequences take longer to complete and an overly long capture may result in motion blur – but using a synthetic green capture can help. Find out how in the step-by-step.

ALL PICTURES: PETE LAWRENCE

STEP BY STEP GUIDE

STEP 1

Mars has an apparent diameter of between 13 an 24 arcseconds at opposition, so you'll need a decent image scale to show much detail. As a guide, aim for a focal ratio of between f/15 and f/45, adjusted by using optical amplifiers such as a Barlow lens. Only use a high image scale if the seeing is good.

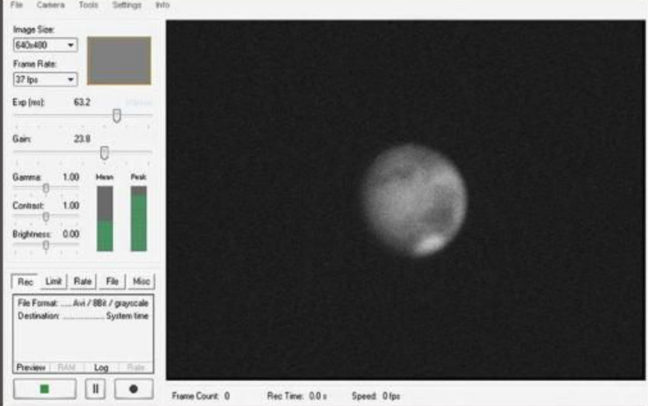
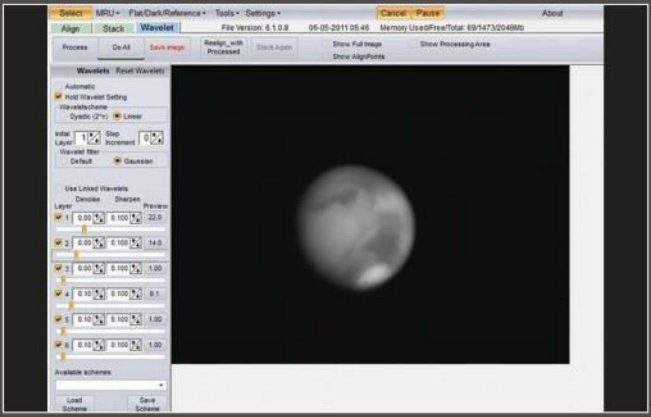


Image Size: 640x480
Frame Rate: 37 fps
Exp (ms): 63.2
Gain: 23.8
Gamma: 1.00
Contrast: 1.00
Brightness: 0.00
File Format: ..... Avi / 8Bit / grayscale
Destination: .... System time
Frame Count: 0
Rec Time: 0.0 s
Speed: 0 fps

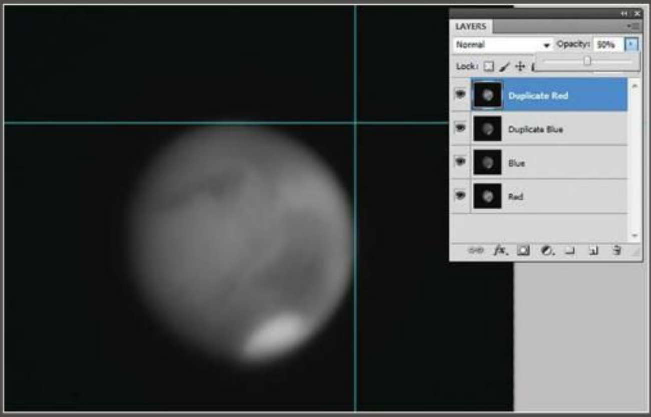
STEP 2

With Mars on chip, select the red filter and focus as quickly and accurately as possible. Aim to collect 2,000-3,000 frames, although try to avoid imaging for more than 90 seconds per filter. Adjust the camera gain and frame rate if necessary to maximise the saturation level for each filter to around 80-90 per cent.



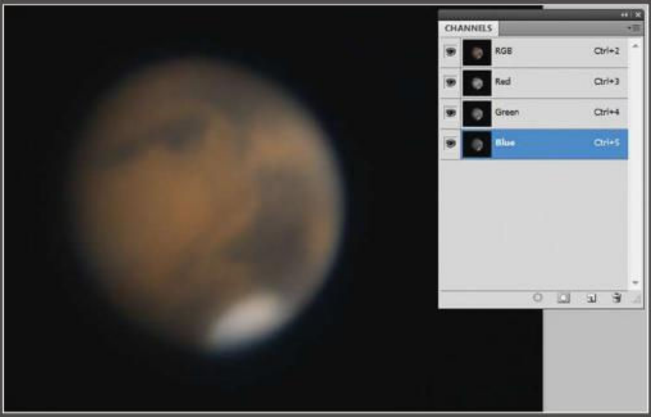
STEP 3

Switch to your blue filter, quickly re-focus and capture the blue image. Repeat the RB sequence as many times as required. When done, load each capture into a stacking program, such as the freeware RegiStax, and process each through to wavelet sharpening. Apply wavelet sharpening to the end result as required.



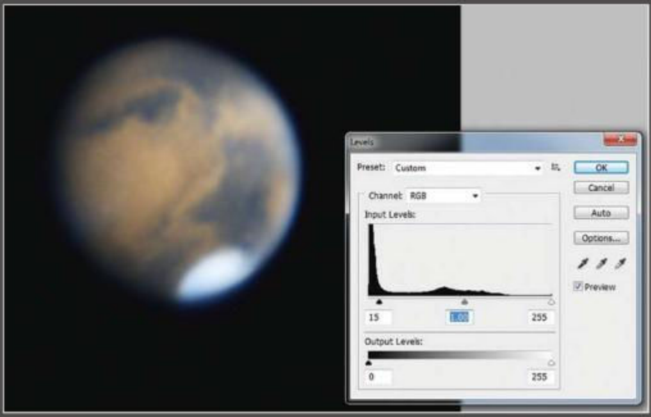
STEP 4

Load an RB pair into a layer-based editor as separate layers. Adjust the upper image so that it is aligned with the lower one and crop to remove any white edges. Duplicate the R and B layers and move to the top of layer stack. Make top layer 50 per cent transparent and merge with the one below – this creates the synthetic green.



STEP 5

Create a blank RGB image with the same dimensions as the image you were working on in step 4. Copy the R image layer to the red channel in the blank image. Repeat for the (G) and B layers, pasting them into their respective green and blue channels. The result should be a full colour R(G)B image showing the distinctive colours of Mars.



Preset: Custom
Channel: RGB
Input Levels: 15 1.00 255
Output Levels: 0 255

STEP 6

Switch to the layers list and duplicate the base R(G)B layer to make your final tweaks. If the colour looks off or subdued, try using the program's auto-colour function; if the colours look too strong after this, try fading the auto-colour back a bit. Adjust the final levels, contrast and brightness to taste. Apply sharpening sparingly.

STARS & NEBULAE

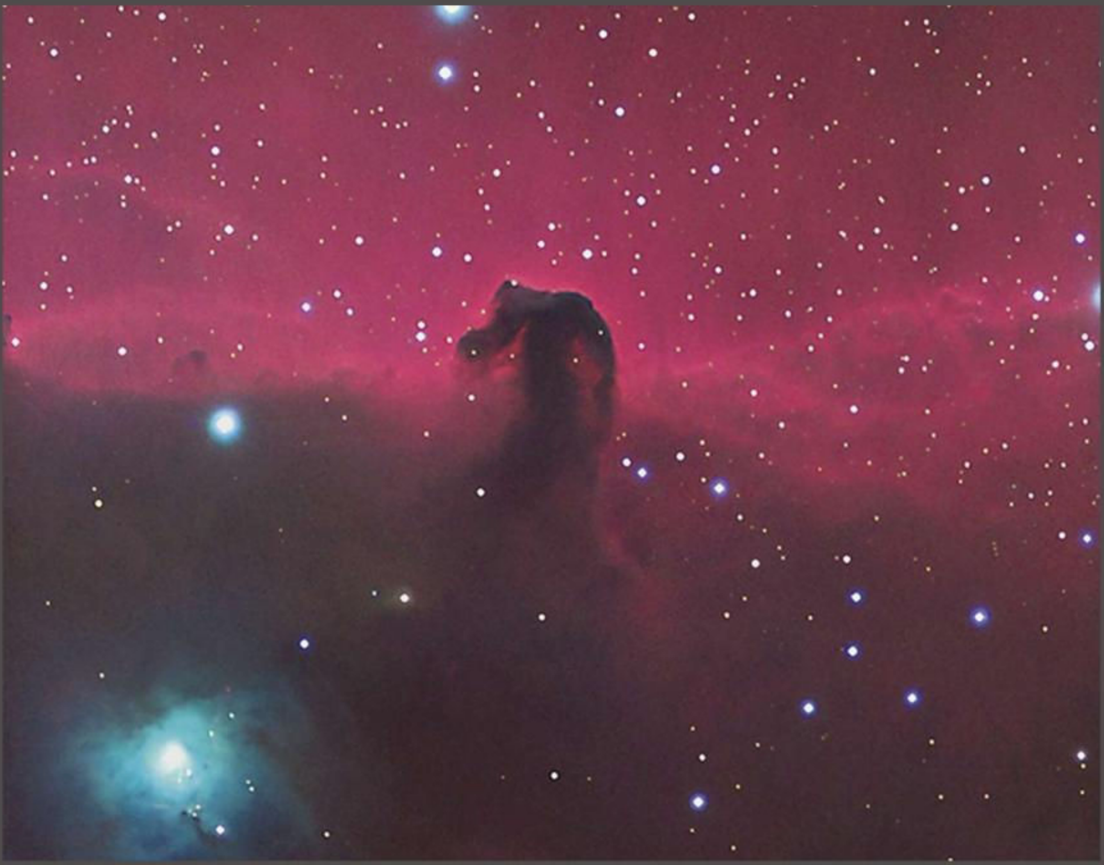
Taking their name from the Latin word for 'cloud', nebulae are interstellar amalgamations of dust, hydrogen, helium or other ionised gases. Many are illuminated by stars embedded in them, and are often star-forming regions such as the Pillars of Creation in the Eagle Nebula. Here, the gas and dust clumps together under gravity to form denser regions – the average density of a nebula is lower than many artificial vacuums created on Earth – eventually becoming dense enough to form stars, planetary systems and other objects. Others, such as the Crab Nebula in Taurus, are the remains of stars blown apart in supernovae, and are still expanding at huge speeds.

THE HEART AND SOUL NEBULAE

FABIAN NEYER, GOSSAU, SWITZERLAND,
SEPTEMBER AND OCTOBER 2010

Fabian says: "I spent 10 nights capturing the 254 individual frames needed to create this image. The total exposure time was 55.7 hours. For this picture I had two particular goals: I wanted to give these well-known nebulae a new look by showing the very faint surrounding hydrogen-alpha emission, and I wanted to give the image a deep colour representation to show the many reflection nebulae in the area."

Equipment: SBIG STL-11000M CCD camera, Tele Vue NP101is apo refractor, Astro-Physics 900GTO mount, Baader HaRGB filters.



◀ THE HORSE HEAD NEBULA

RICK PECCE, ESSEX, NOVEMBER 2008

Rick says: "I've been wanting to take a decent image of the Horsehead Nebula for quite some time, but was never happy with the result. This is one of my best. It was taken over several nights with a few cloudy nights in between and some patience and perseverance."

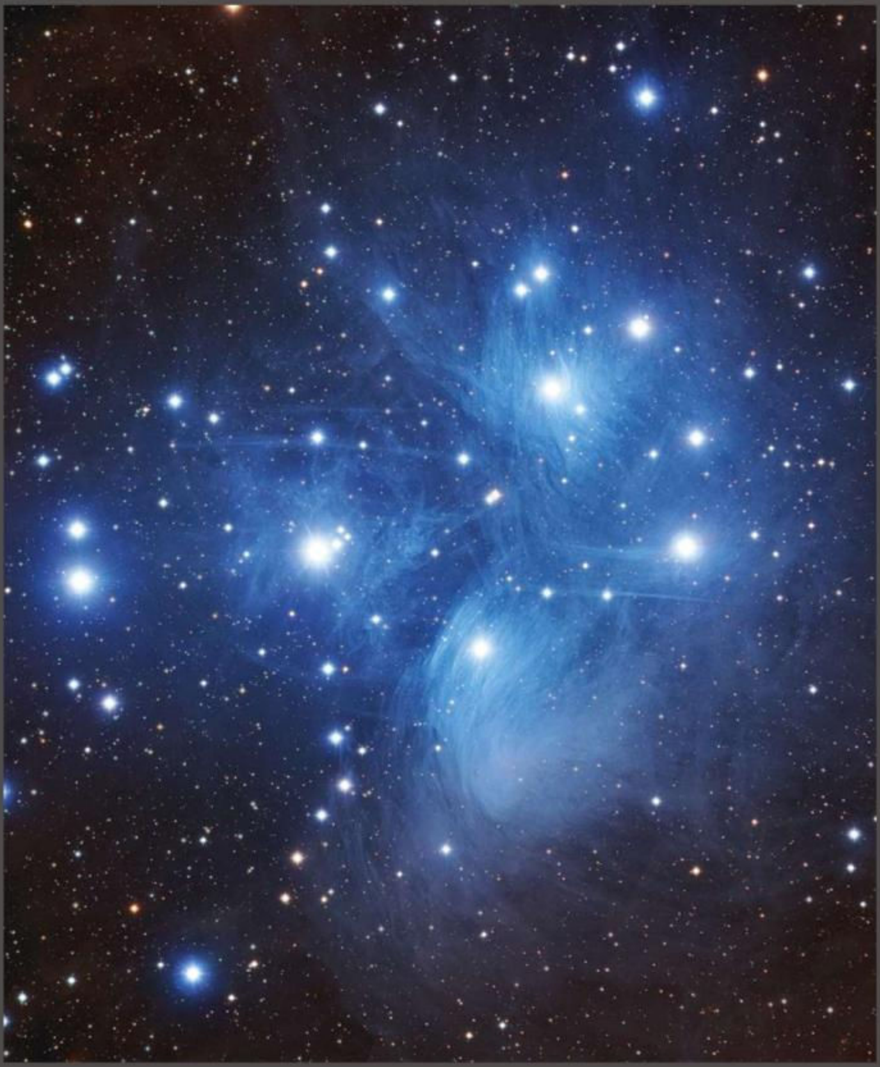
Equipment: SBIG ST-2000XM CCD camera, Meade 127 ED refractor, Losmandy G11 mount.

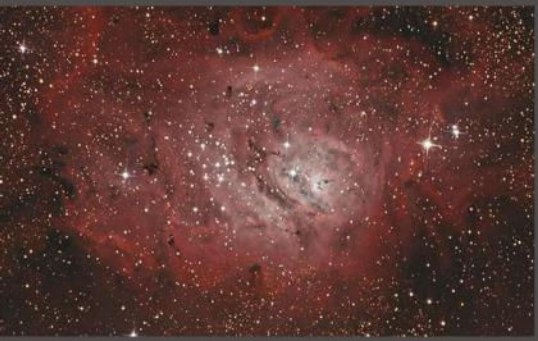
THE PLEIADES ▶

BOB FRANKE, ARIZONA, USA, JANUARY 2013

Bob says: "It took eight nights to accumulate the 670 minutes of LRGB data for this winter classic. The Pleiades is probably the most famous cluster in the sky and is best viewed with binoculars or a small telescope."

Equipment: SBIG STF-8300M CCD camera, Takahashi 106ED telescope, Baader LRGB filters, Losmandy G11 mount.



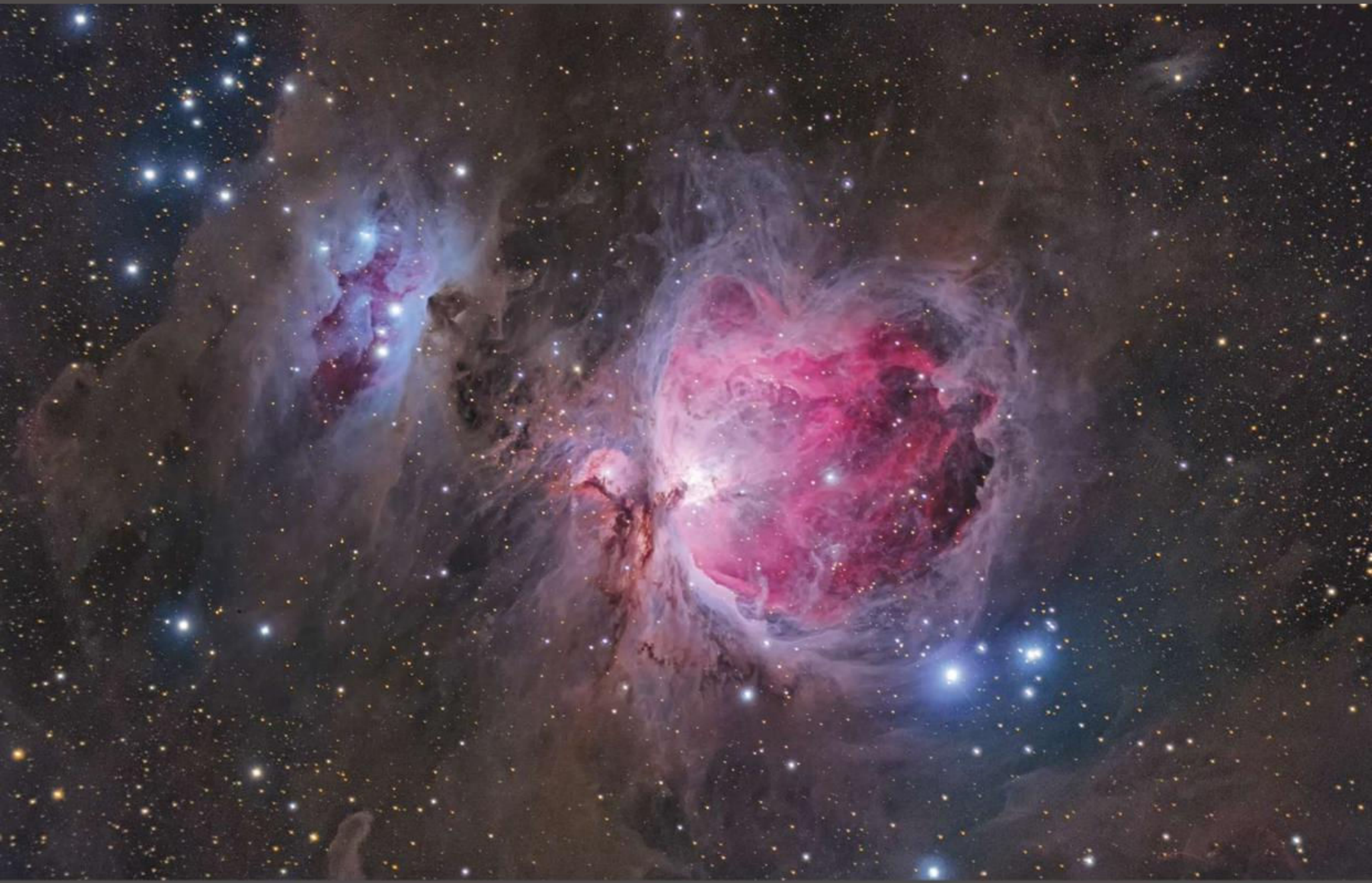


▲ M8, THE LAGOON NEBULA

SAM LESKE, NEW ZEALAND, 4 JULY 2010

Sam says: "I really like this image as the extent of the nebula can be seen and the dense bright middle shows quite a bit of detail. This is a fascinating part of the sky."

Equipment: Modified Canon EOS 1000 DSLR camera, Sky-Watcher 250PX 10-inch reflector, EQ6 SynTrek mount.



▲ M42, THE ORION NEBULA

ANNA MORRIS, SUFFOLK, 5 DECEMBER 2013

Anna says: "This image shows just how much dust is around the Orion Complex and the large array of colours in the region that you don't see well when viewing through an eyepiece. It also shows what can be imaged even with modest equipment given some patience and time."

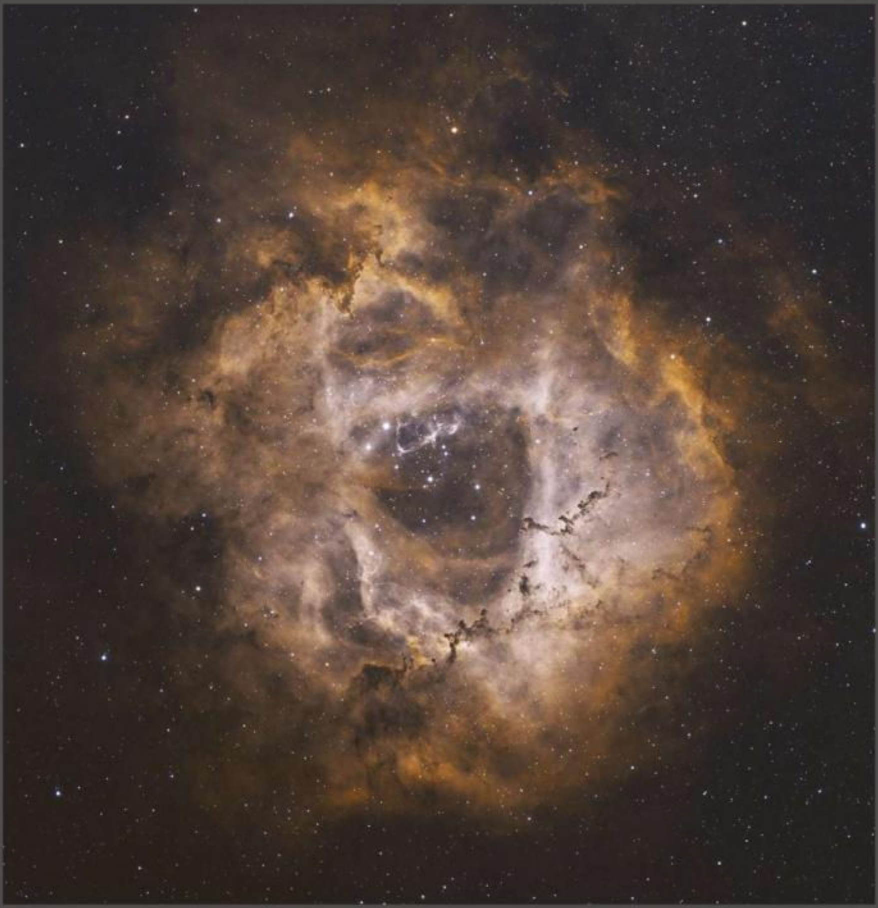
Equipment: Nikon D7000 DSLR camera, Orion EON 80ED telescope.

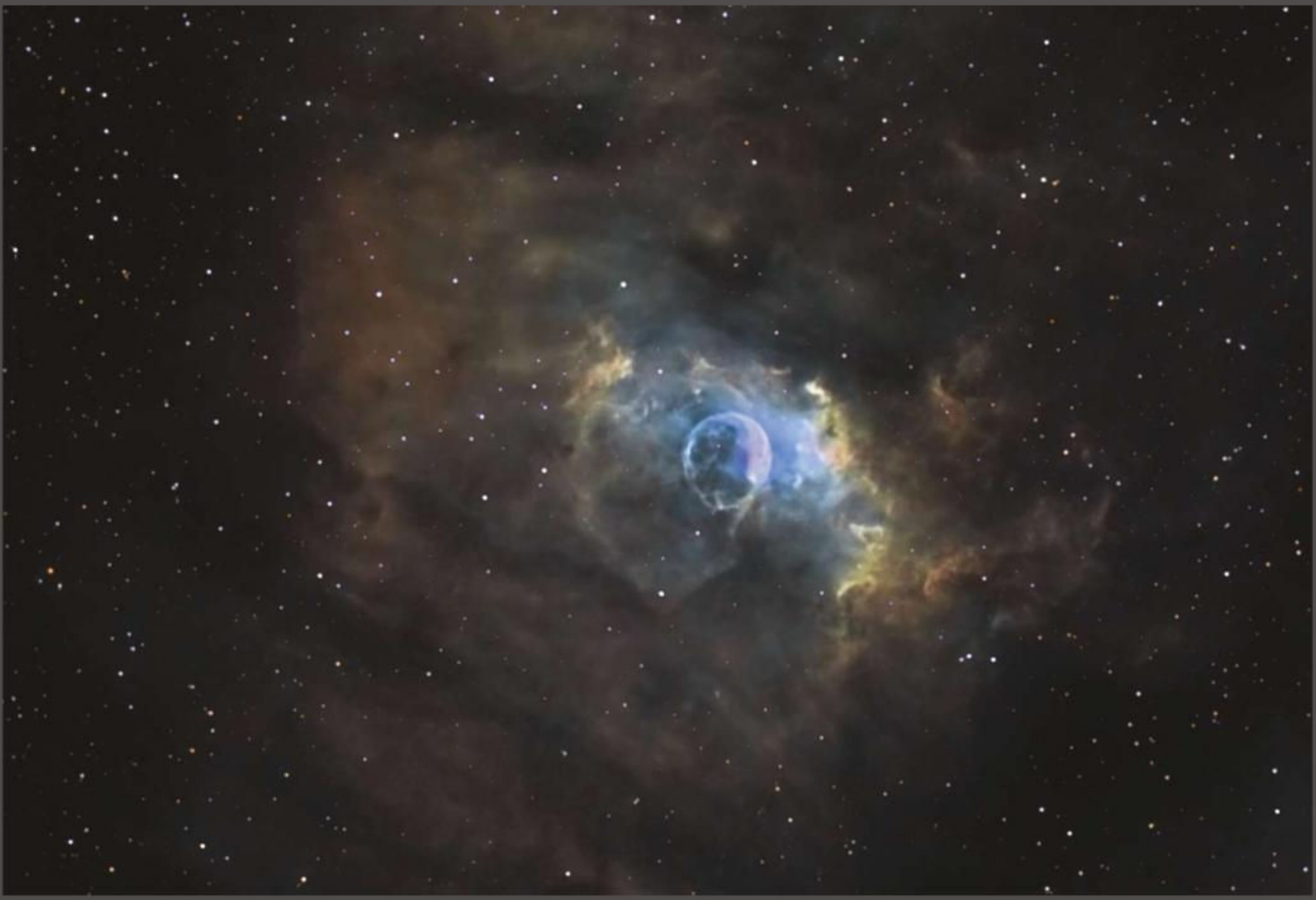
NGC 2237, THE ROSETTE NEBULA ▶

CHRIS HEAPY, MACCLESFIELD, 31 DECEMBER 2015

Chris says: "The Rosette Nebula is quite large and difficult to fit onto the sensor. I set out to capture a three-channel Hubble composition but poor weather put paid to that idea, so the image consists of just two channels, OIII and Ha composited as a bi-colour image."

Equipment: Moravian G4-16000 CCD camera, Tele Vue NP127is refractor, 10-Micron GM2000 HPS mount.



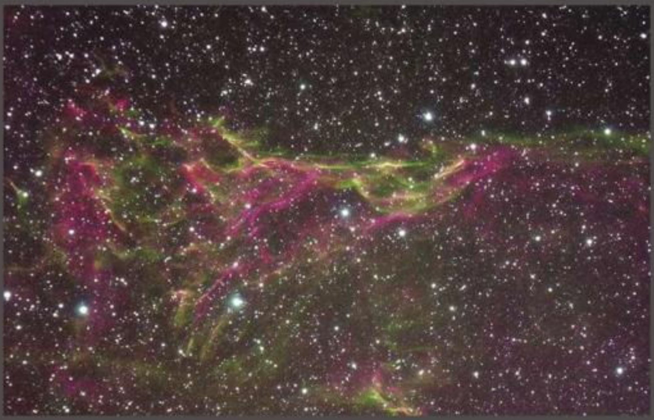


▲ NGC 7635, THE BUBBLE NEBULA

CHRIS GRIMMER, NORFOLK, USA, 5 JANUARY 2014

Chris says: "I took this image in January 2014, but struggled to process it to my satisfaction. Finally, with another year's experience under my belt, I got an image I'm happy with!"

Equipment: Starlight Xpress SXVR-H694 CCD camera, William Optics GT-81 telescope, Sky-Watcher HEQ5 Pro mount, Baader Ha, OIII and SII filters.

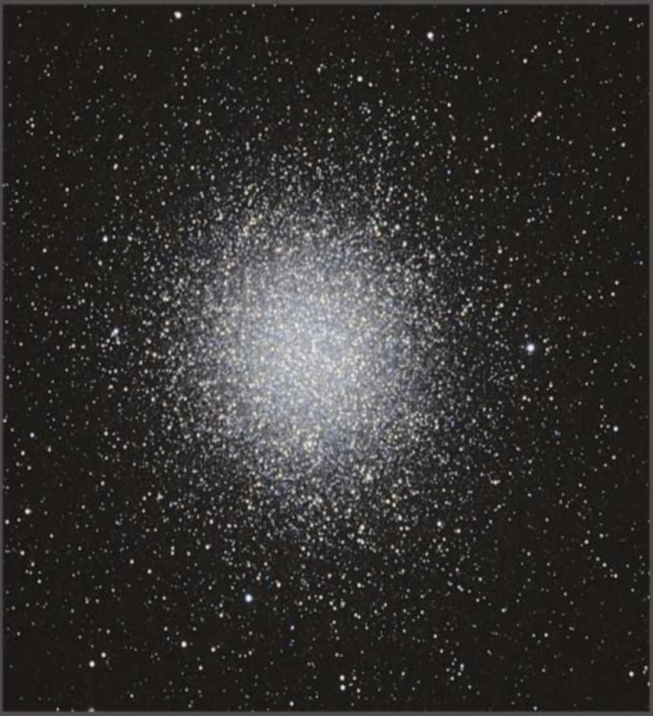


▲ NGC 6979, PICKERING'S TRIANGLE

IAN KING, PADDOCK WOOD, KENT, 26 AUGUST 2005

Ian says: "I used narrow-band filters with H-alpha, OIII and SII assigned to the RGB channels."

Equipment: Starlight Xpress SXV-H9 CCD camera, Zenithstar 80 refractor.

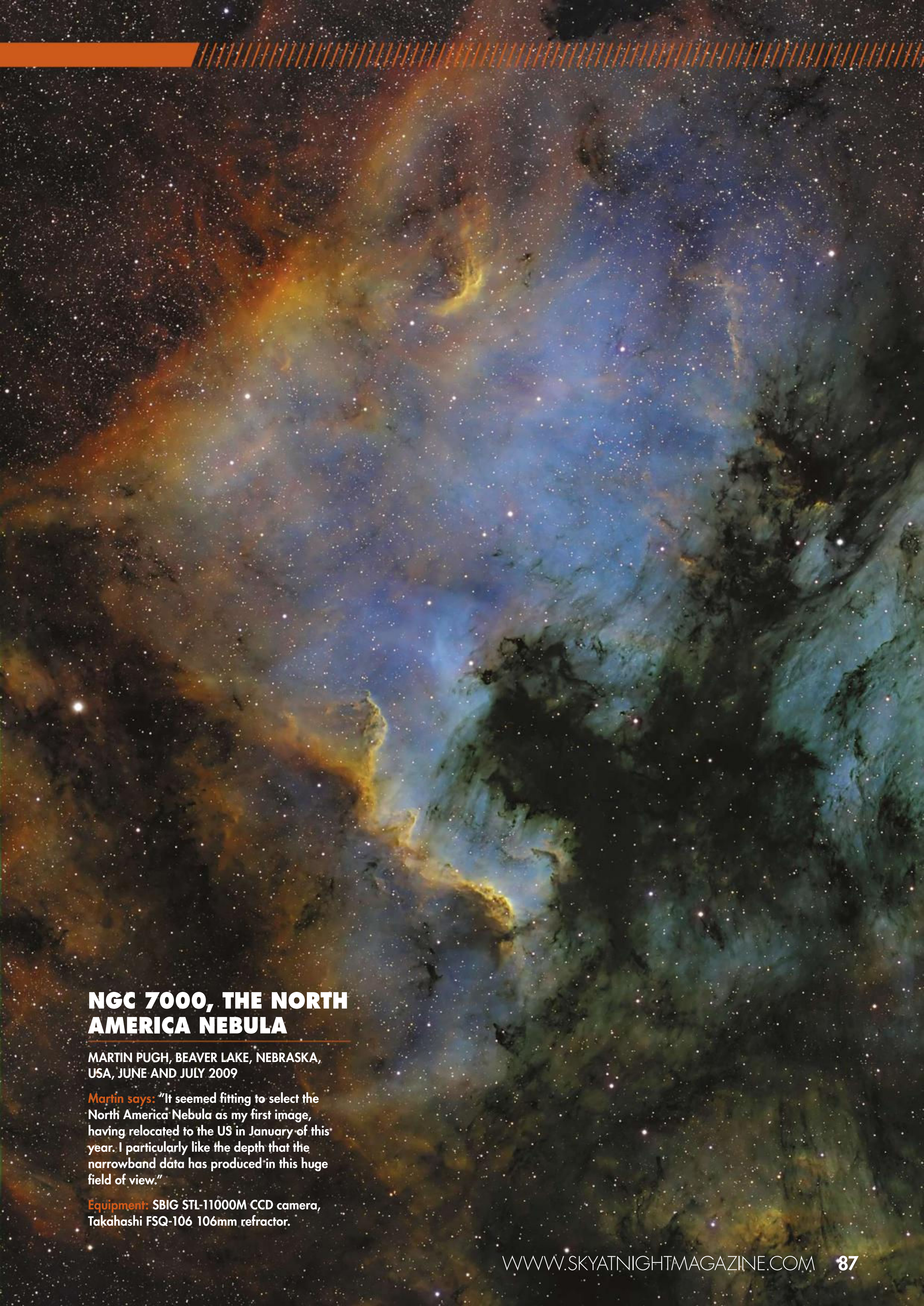


◀ NGC 5139, OMEGA CENTAURI

PABLO VERA TIZNADO, SANTIAGO, CHILE, DATE UNSUPPLIED

Pablo says: "This globular cluster is about 16,000 lightyears from Earth. It is the brightest globular in the sky, contains about 10 million stars and has a diameter of roughly 150 lightyears. The stars in the core are estimated to be only 0.1 lightyears away from each other."

Equipment: Canon EOS T3i DSLR camera, Orion 8-inch f/3.9



NGC 7000, THE NORTH AMERICA NEBULA

MARTIN PUGH, BEAVER LAKE, NEBRASKA, USA, JUNE AND JULY 2009

Martin says: "It seemed fitting to select the North America Nebula as my first image, having relocated to the US in January of this year. I particularly like the depth that the narrowband data has produced in this huge field of view."

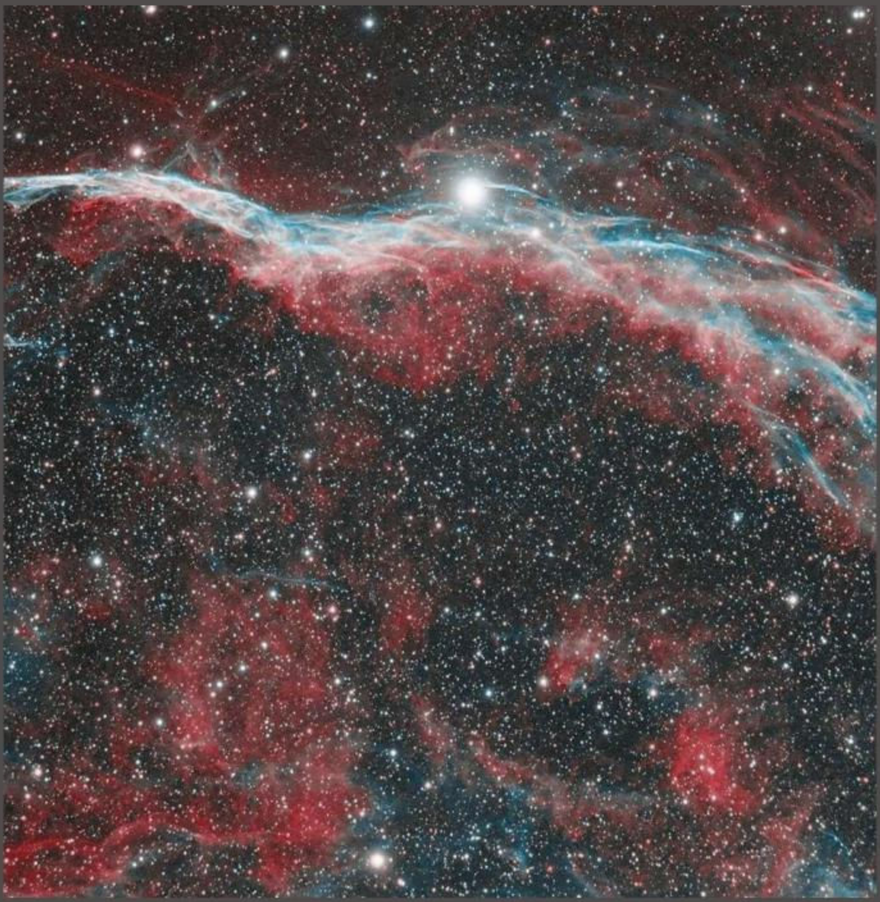
Equipment: SBIG STL-11000M CCD camera, Takahashi FSQ-106 106mm refractor.

THE WESTERN VEIL NEBULA ▶

ROBERT FISHER, CUMBRIA, 23 JULY 2011

Robert says: "I was pleased with the final result because the image shows a good deal of nebulosity surrounding the main object, without the stars bloating and dominating too much. The outer layers have been resolved above the main 'broom' area too."

Equipment: Atik 4000 CCD camera, William Optics FLT 132 refractor, EQ6 Pro mount.

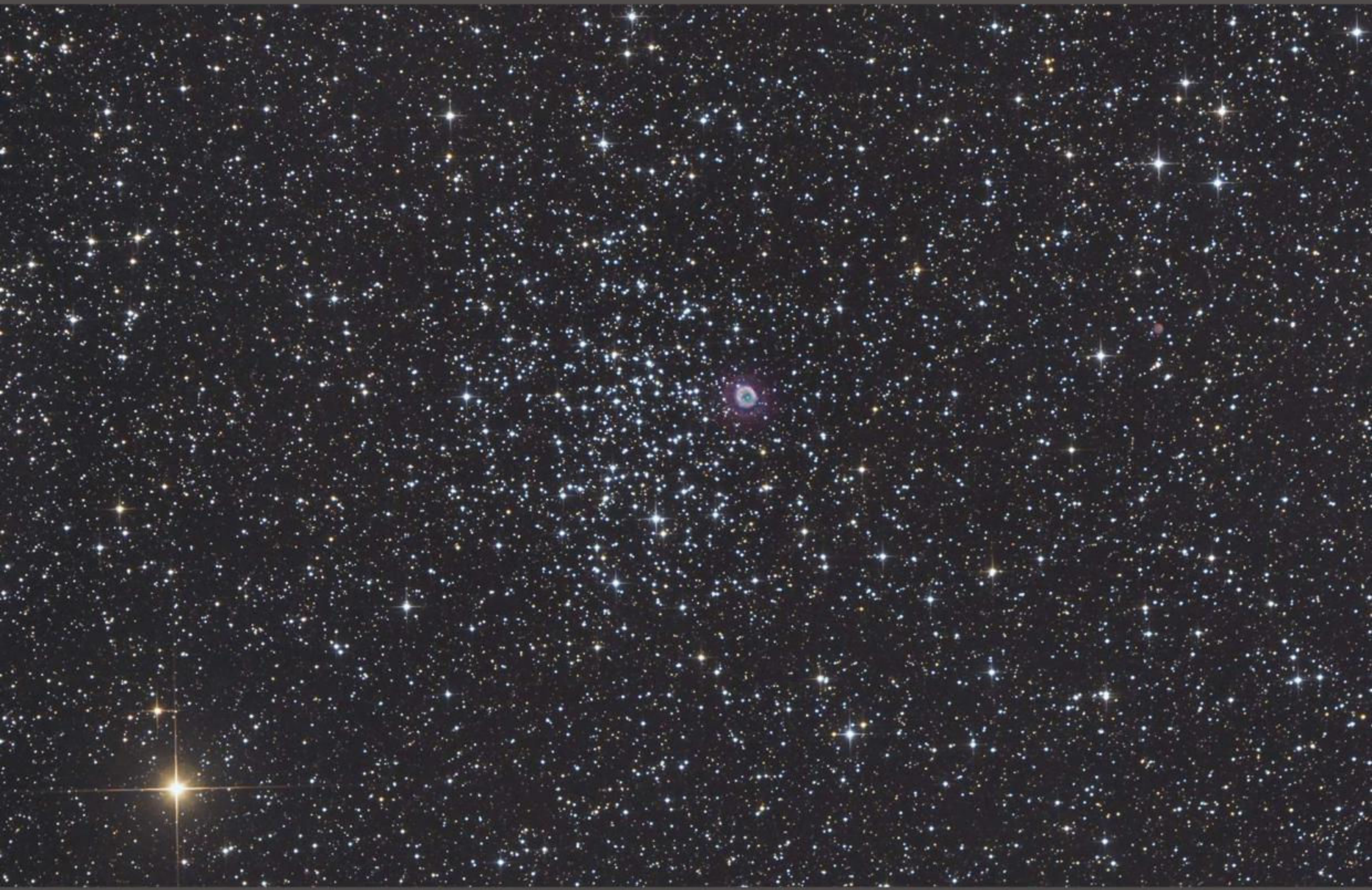


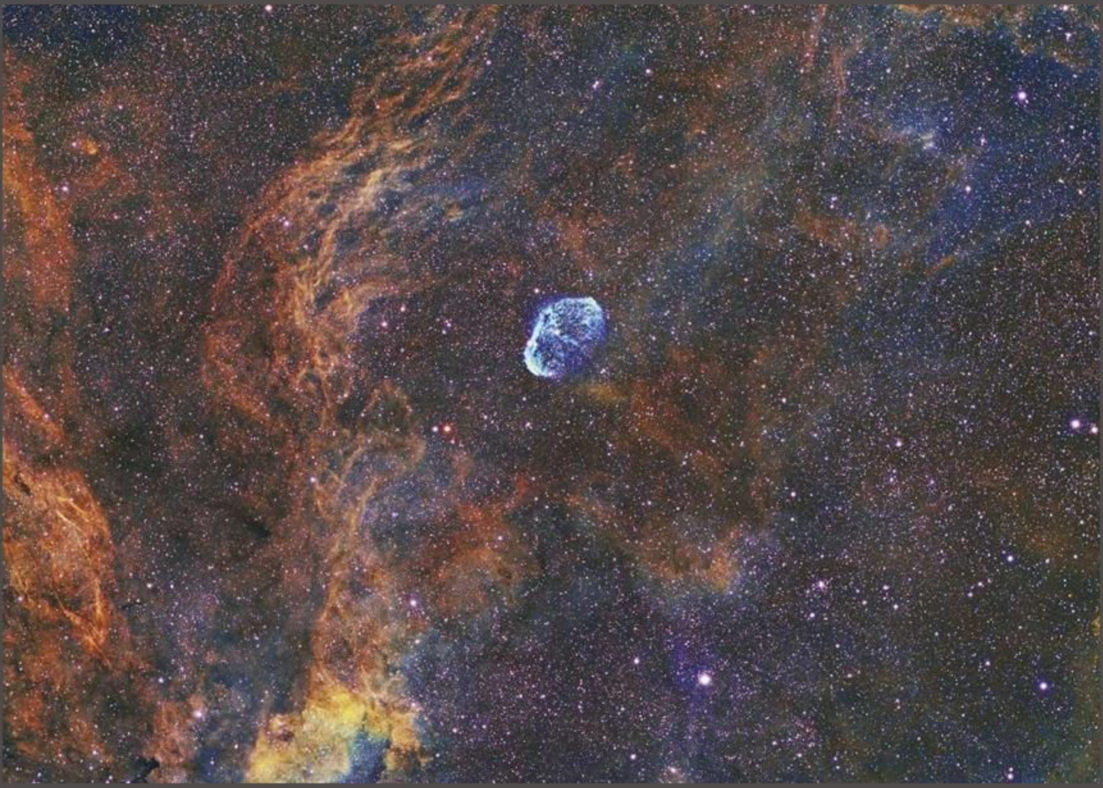
▼ PLANETARY NEBULA NGC 2438 IN M46

KFIR SIMON, NAMIBIA, MAY-DECEMBER 2015

Kfir says: "When I planned my trip to Tivoli Farm in Namibia in 2015, I put this target on my 'to do' list. A single 20-minute frame in hydrogen alpha didn't show anything; it was only after stacking that the shell of the planetary nebula began to appear."

Equipment: Apogee Alta CCD camera, Dream 16-inch Newtonian telescope.





▼ IC410

THOMAS WESTERHOFF, GERMANY, 10 FEBRUARY 2008

Thomas says: "For this image I used the Hubble Space Telescope's colour palette to map the filtered black-and-white images to each red, green and blue channel. It was my first attempt at narrowband imaging and I hope to do many more in the future."

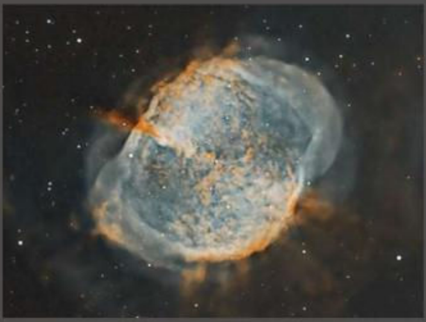
Equipment: SBIG STL-6303E CCD camera, 20-inch Newtonian telescope, Astronomik narrowband filters.

▲ NGC 6888, THE CRESCENT NEBULA

GORDON HAYNES, HEREFORD, JULY 2010

Gordon says: "I like the contrast of the blue of the crescent compared to the reddish colours of the surrounding hydrogen clouds, which helps to highlight the different gases present. The wide-field view afforded by my equipment gives more context to the size of the Crescent compared to its surroundings."

Equipment: Starlight Xpress SXVF-H36 CCD camera, Takahashi FSQ-106ED refractor.

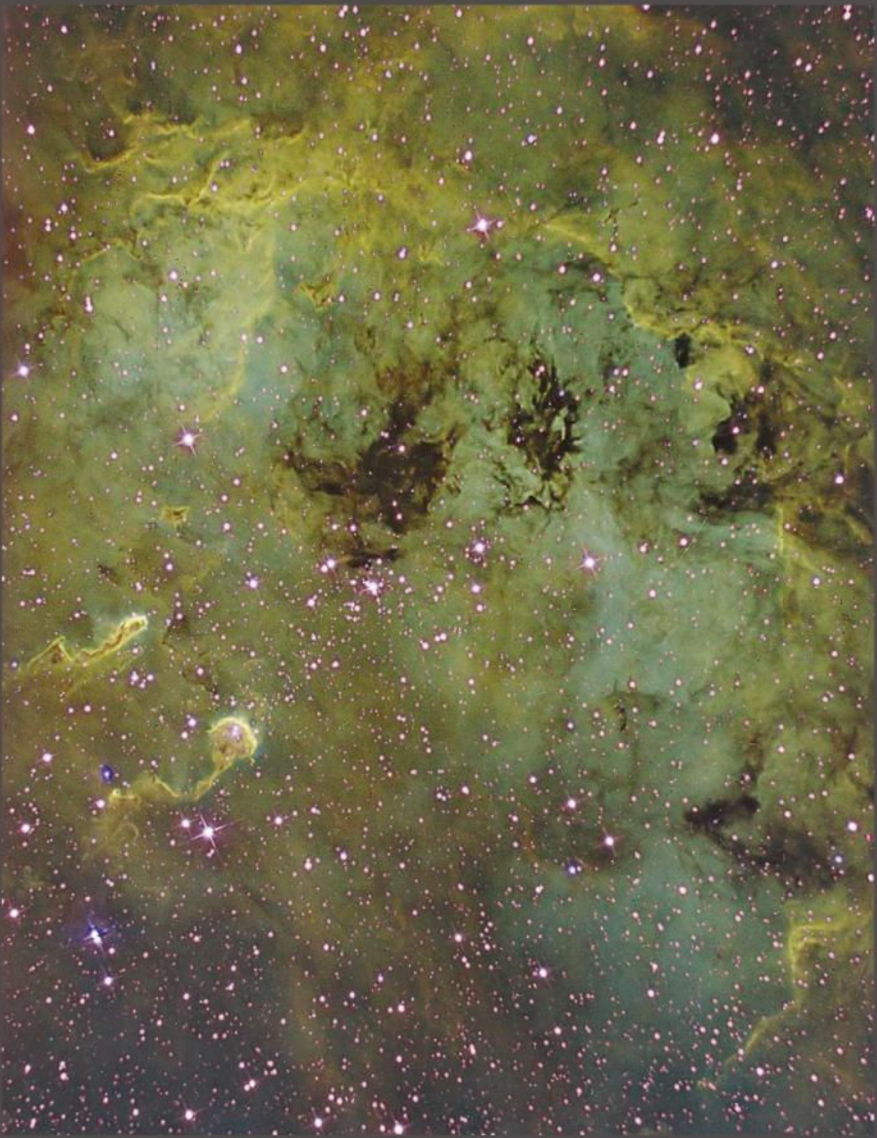


▲ M27, THE DUMBBELL NEBULA

IAN RUSSELL, SUTTON COURTENAY, 23 OCTOBER 2013

Ian says: "For a planetary nebula, M27 has a large angular size and is quite bright in Ha and OIII. I was delighted to bring out the outer halo with only two hours of data."

Equipment: Atik 490EX CCD camera, Celestron CGEM 11-inch Edge HD telescope, Celestron CGEM DX mount.

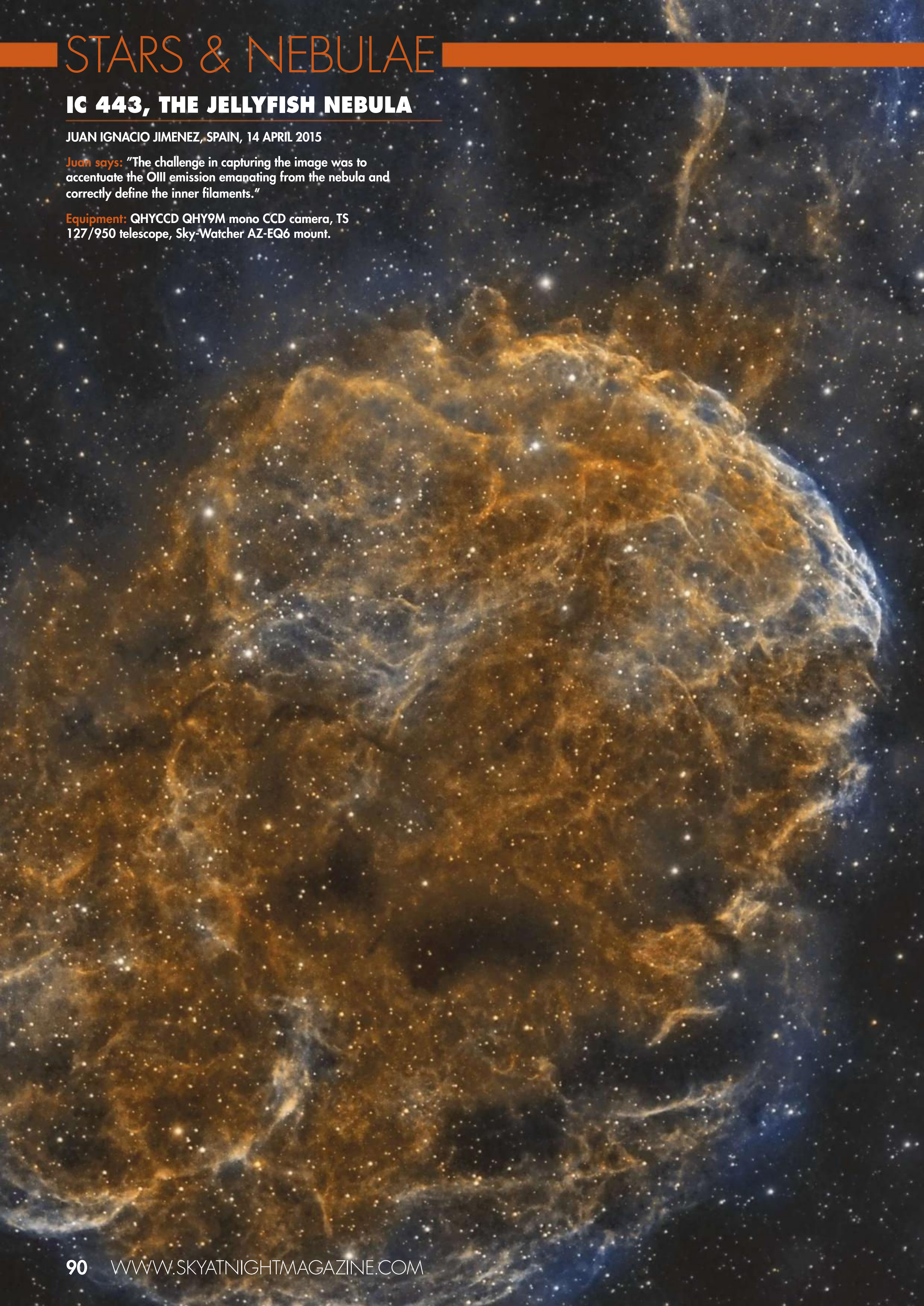


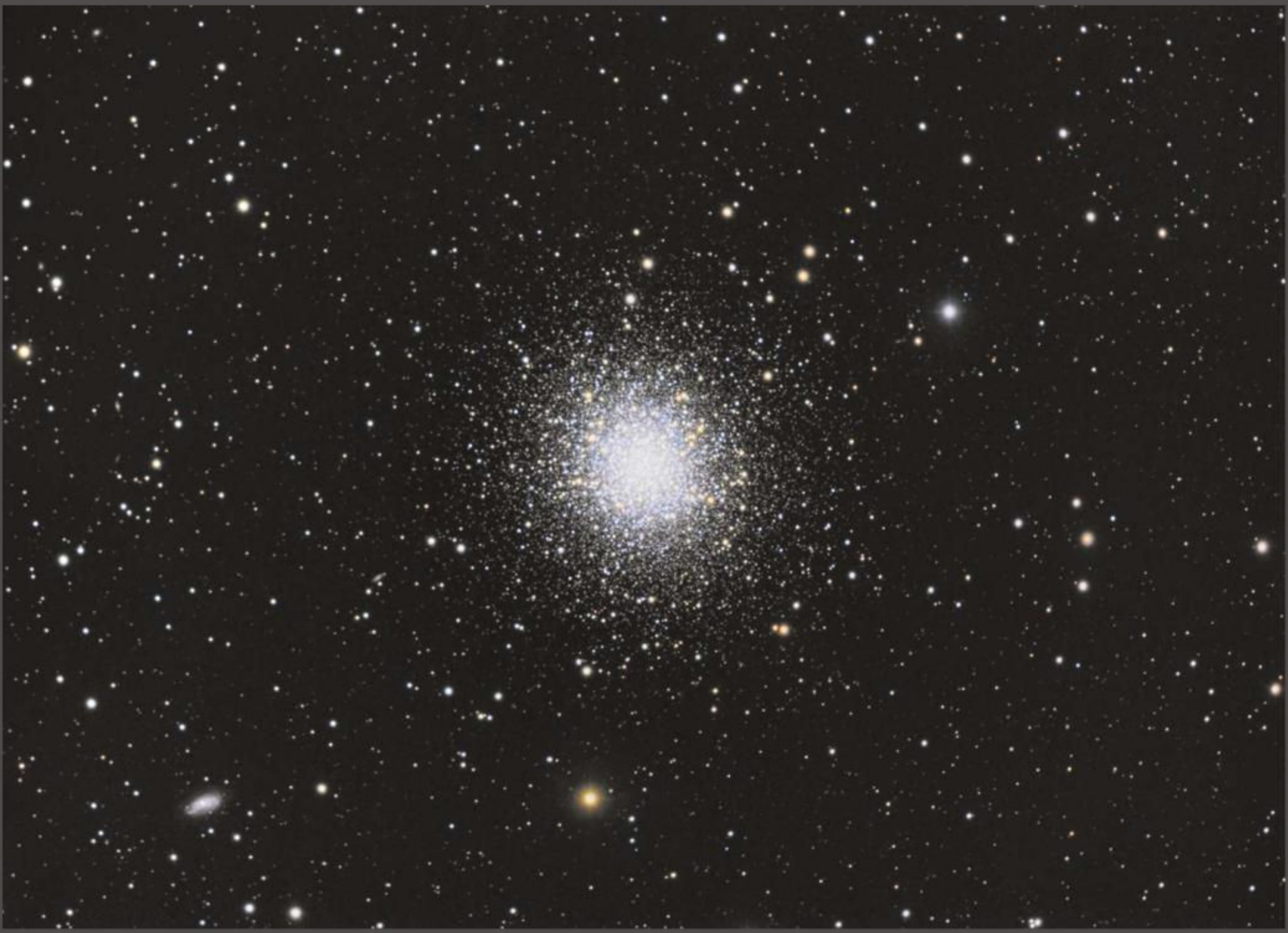
IC 443, THE JELLYFISH NEBULA

JUAN IGNACIO JIMENEZ, SPAIN, 14 APRIL 2015

Juan says: "The challenge in capturing the image was to accentuate the OIII emission emanating from the nebula and correctly define the inner filaments."

Equipment: QHYCCD QHY9M mono CCD camera, TS 127/950 telescope, Sky-Watcher AZ-EQ6 mount.





▲ M13

JACOB BASSØE, FREDERIKSBERG, DENMARK, APRIL AND MAY 2009

Jacob says: "M13 [the Great Globular Cluster in Hercules] looks beautiful through a telescope or a pair of binoculars, but especially so in photos! Even my wife, who isn't interested in astronomy, liked the view."

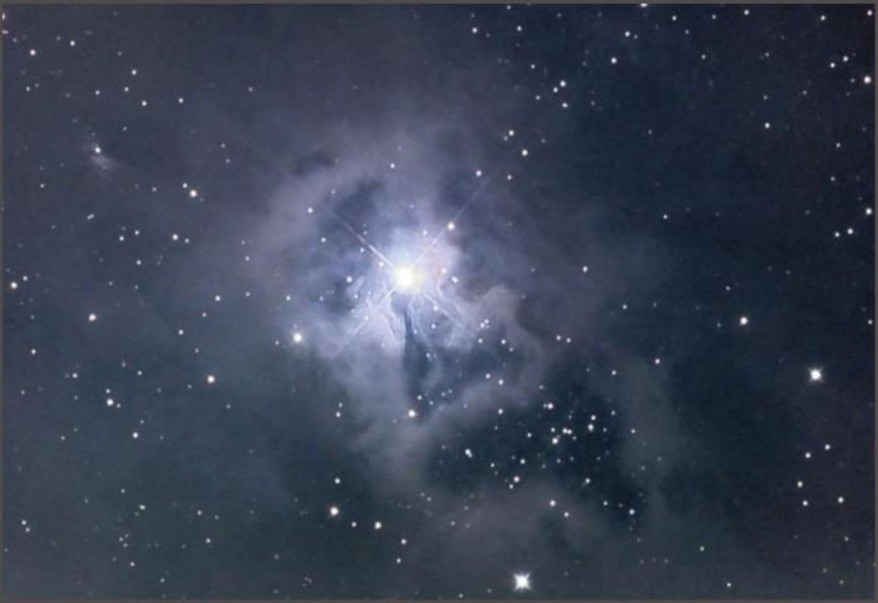
Equipment: QHY2 Pro CCD camera, Takahashi FSQ 85 refractor.

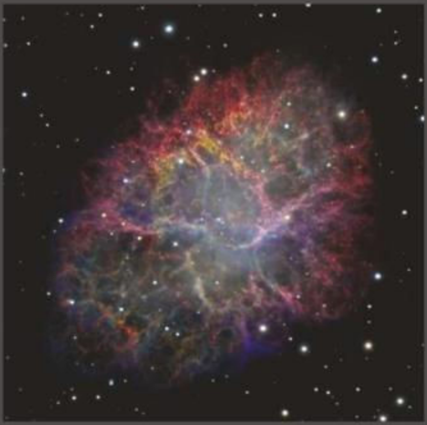
▼ NGC 7023, THE IRIS NEBULA

FILIPPO CIFERRI, ROME, ITALY, 20-25 JULY 2006

Filippo says: "There was a lot of light pollution in the sky, so I sampled 11 hours of data to create this image."

Equipment: SBIG ST10 XME CCD camera, Vixen Visac Cassegrain telescope, Celestron CGE mount.



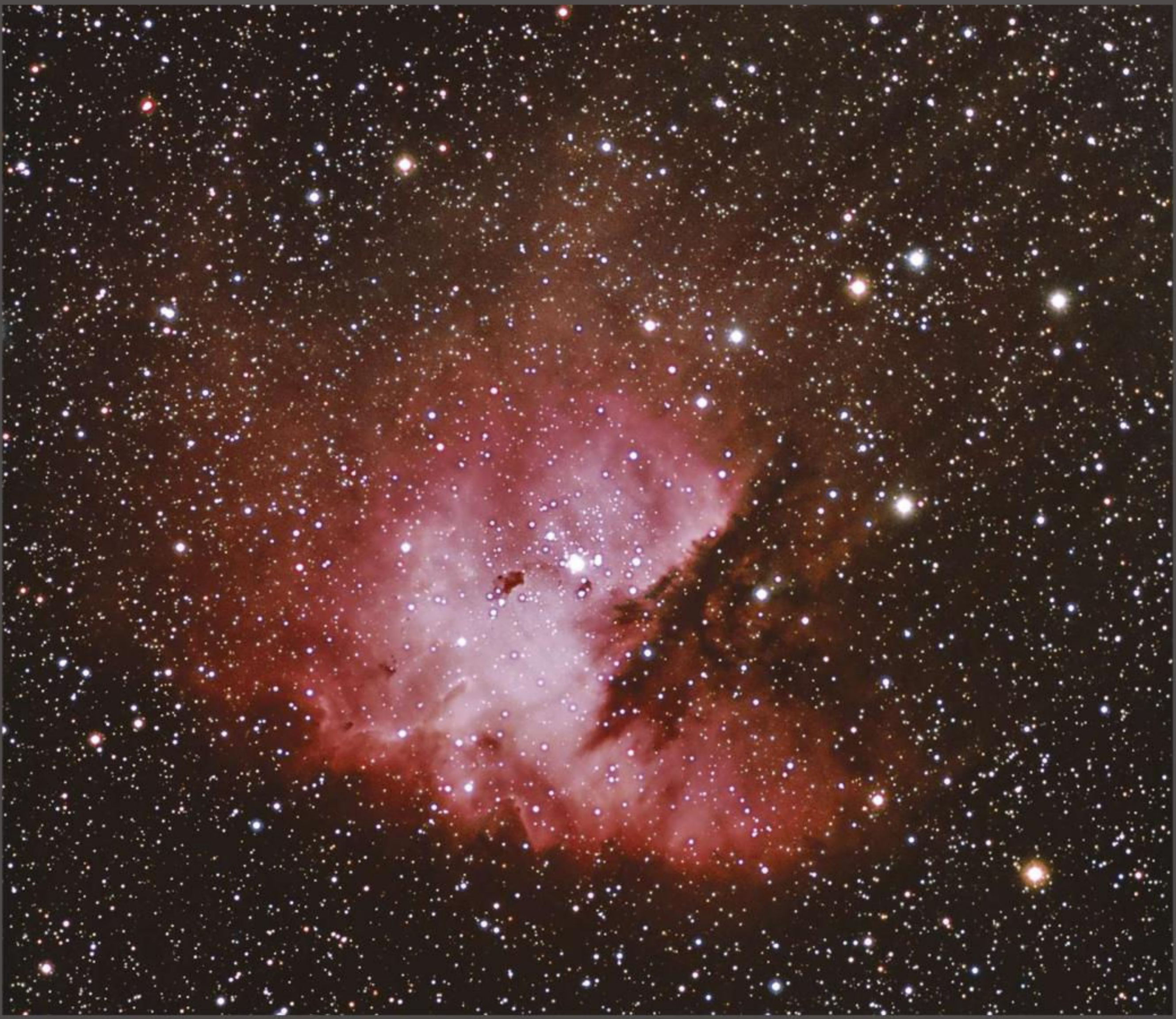


▲ M1, THE CRAB NEBULA

ROB HODGKINSON, DORSET, NOVEMBER 2011

Rob says: "The detail in the filaments has come out really nicely and there is fine detail right down to the central pulsar. Also, the colour mapping has made the whole thing look very much like what it is – a vast cloud of hot ionised gases rushing outwards at phenomenal speed, pushed by the huge energies of the supernova."

Equipment: Atik 16HR CCD camera, Celestron 11-inch EdgeHD Schmidt-Cassegrain telescope, Astro-Physics 0.67x focal reducer, Astronomik filters.



▲ NGC 281, THE PAC-MAN NEBULA

STEVE ALLAN, SANDBACH, UK, SEPTEMBER 2010

Steve says: "I particularly like this image as it is the first time I have attempted to add hydrogen-alpha data to an LRGB image of a nebula. I'm really pleased with the structure and outer nebula dust showing on the Pac-Man."

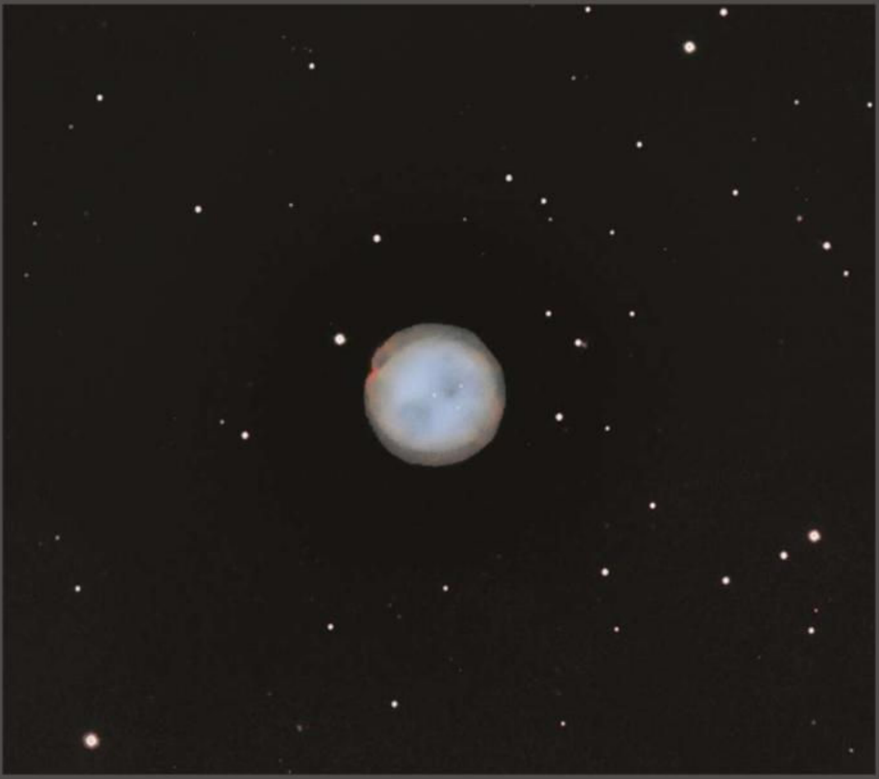
Equipment: QHY9 CCD camera, Sky-Watcher ED 120mm Pro refractor, EQ6 Pro mount.

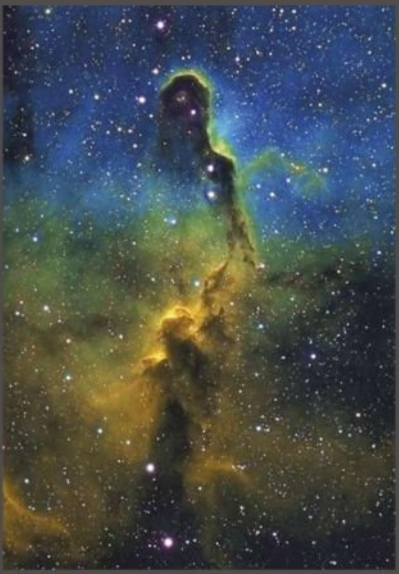
THE OWL NEBULA ▶

RICHIE JARVIS, SOUTH CHAILEY, EAST SUSSEX, 1 AND 18 APRIL 2009

Richie says: "This was taken shortly after the Isle of Wight Star Party, where I had failed to capture the galaxies M92 and M108. I decided to concentrate on just the Owl Nebula (M97) itself, and this is the result."

Equipment: Starlight Xpress SXV-H9 CCD camera, Astro Professional 102ED refractor.





◀ THE ELEPHANT'S TRUNK NEBULA

DANNY WILLIAMS, LEICESTERSHIRE, 26-28 SEPTEMBER 2011

Danny says: "I love how the image came together to produce the classic gold and turquoise colours."

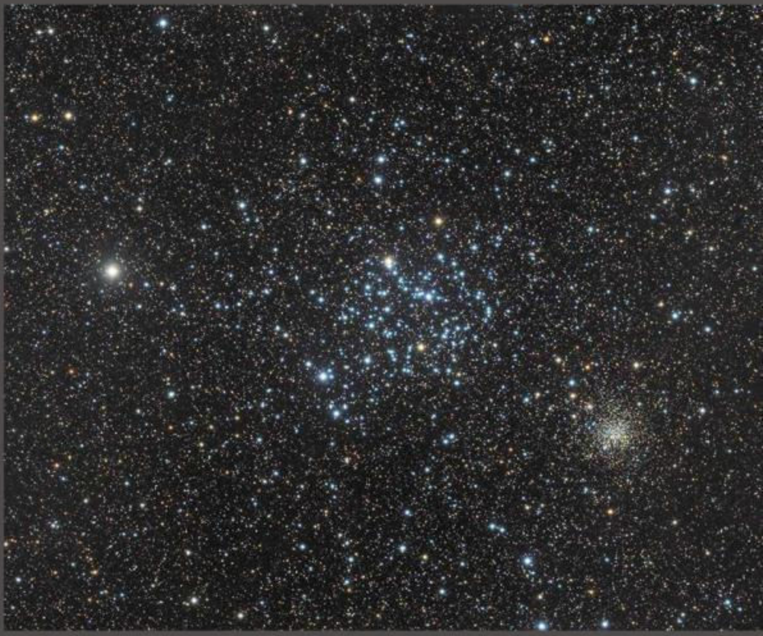
Equipment: Atik 314L CCD camera, William Optics FLT 98 refractor, Baader Ha, SII and OIII narrowband filters.

▼ M35 AND NGC 2158

DAN CROWSON, MISSOURI, 12 NOVEMBER 2013

Dan says: "The main open cluster in this image is M35, located approximately 2,800 lightyears away in Gemini. The open cluster that looks like a globular is NGC 2158."

Equipment: SBIG ST-8300 CCD camera, Astro-Tech AT90DT refractor.

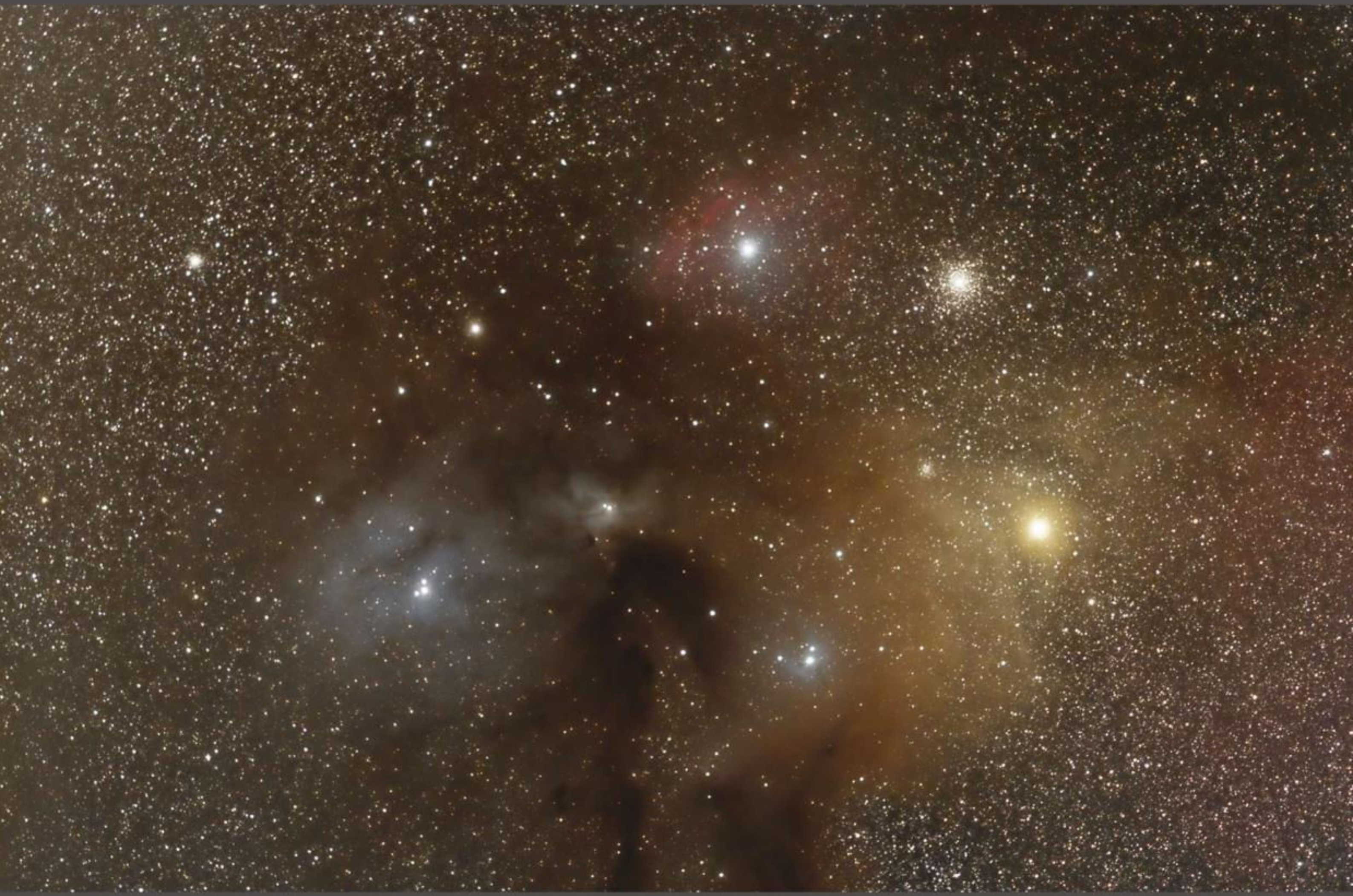


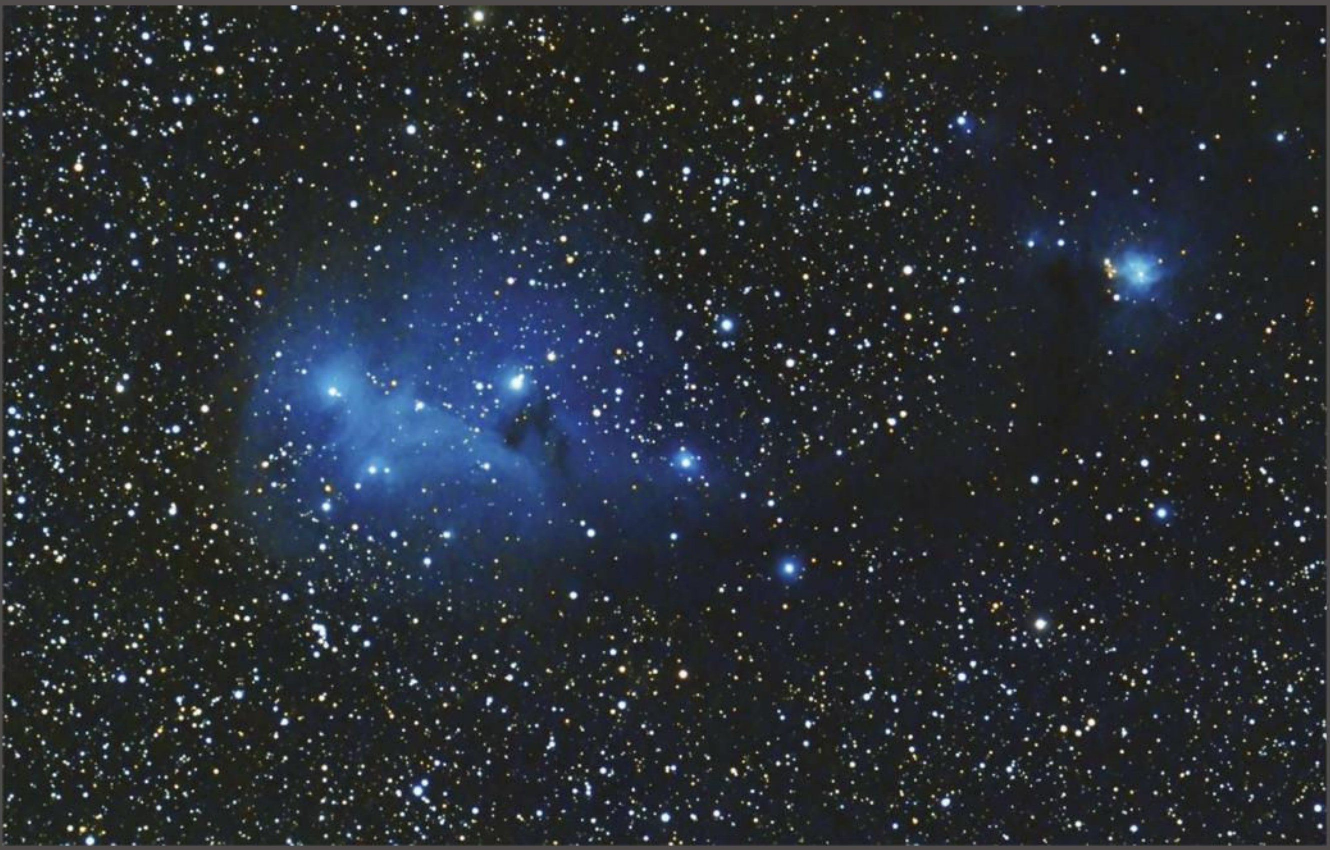
▼ ANTARES REGION

ROBERT MERCER, EL PASO, LA PALMA, 21 MARCH 2012

Robert says: "The area around the star Antares is one of my favourite parts of the sky and one I've always wanted to capture. A recent visit to La Palma gave me that opportunity. I'm really chuffed at how it came out."

Equipment: Starlight Xpress SXVF-M25C CCD camera, 200mm lens, Mk 1 AstroTrac mount, photographic tripod.



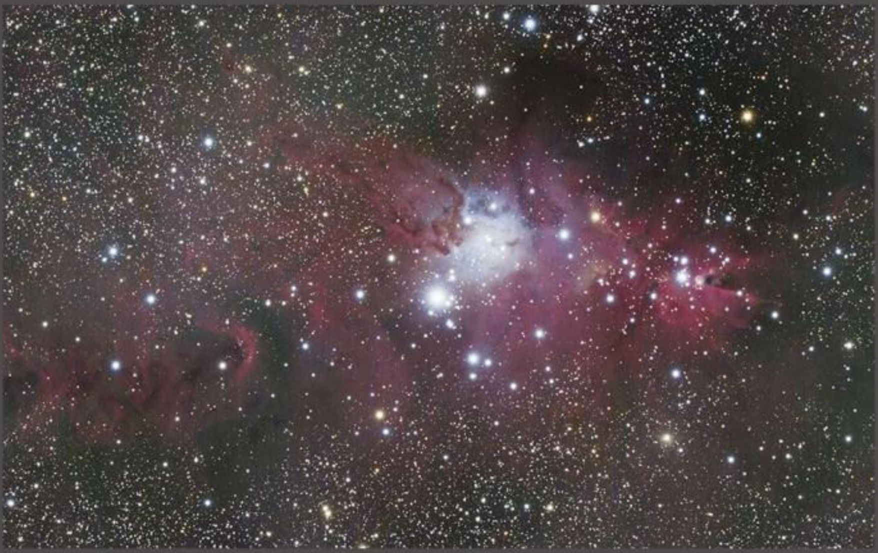


▲ NEBULA IC 447

GARY OPITZ, NEW YORK, USA, 6 JANUARY 2016

Gary says: "I chose this target because of its beautiful blue colour due to dust reflection – from the embedded stars of the open cluster Collinder 95 – and the fact that one seldom sees just a blue reflection nebula without an associated red emission component."

Equipment: Canon EOS 60Da DSLR camera, TEC 5.5-inch apo refractor, Orion Atlas mount.

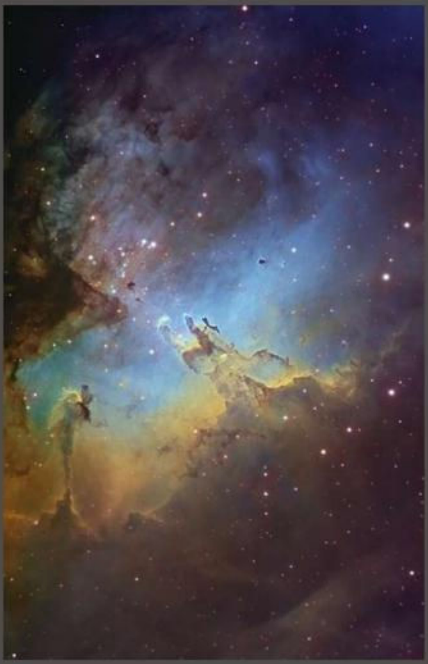


▲ FOX FUR AND CONE NEBULAE

STEVE PORTER, BARDSEY ISLAND, NORTH WALES, 10 DECEMBER 2010

Steve says: "This is the longest amount of time that I've put into an imaging target (seven hours). The Cone Nebula is part of a large area of faint nebulosity that rewards time given to drawing out some of the detail."

Equipment: Modified Canon EOS 5D Mark II DSLR camera, William Optics FLT 132 refractor, EQ6 Pro mount.

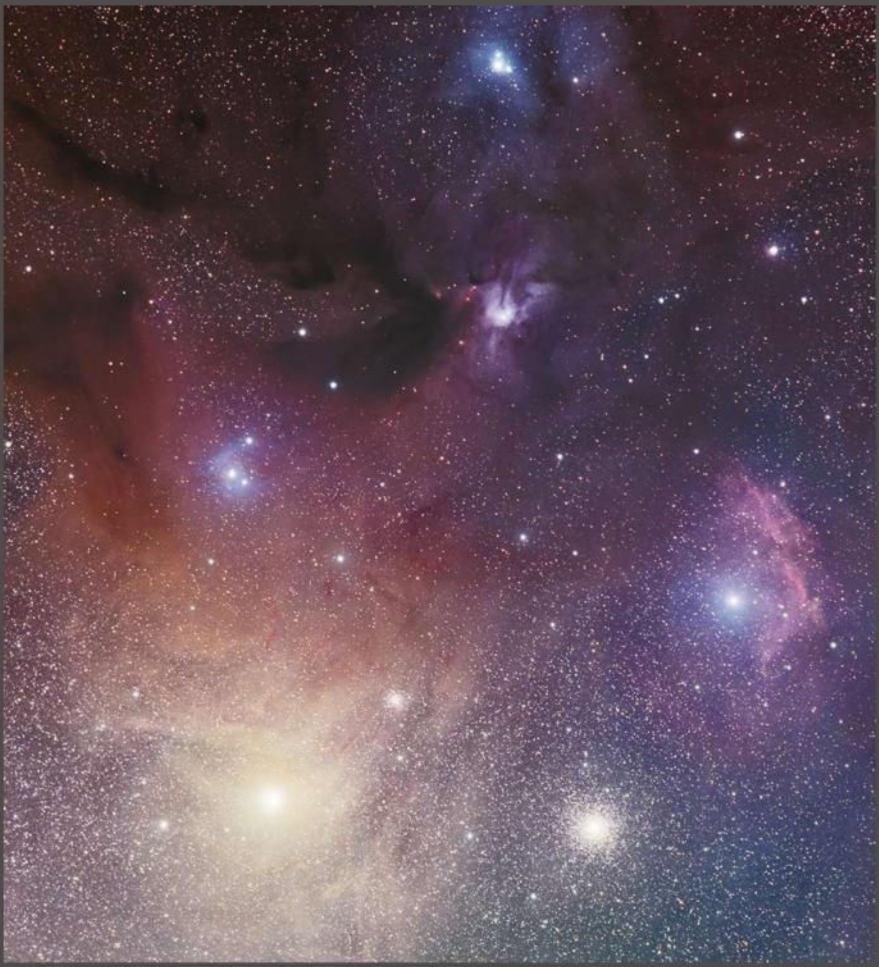


▲ THE EAGLE NEBULA

MARTIN BRADLEY, CHESTERFIELD, SUMMER 2011

Martin says: "This is a very tricky object to image from the UK, due to it being so low down. Hubble's 'Pillars of Creation' image has been a real inspiration for me, so I felt I had to try to capture it and use a respectably long focal length to show the 'pillars'."

Equipment: QSI 532 ws CCD camera, 10-inch Meade LX200 Schmidt-Cassegrain telescope, Takahashi EM200 mount.



◀ THE ANTARES-RHO OPHIUCHUS REGION

GIOVANNI BENINTENDE, SICILY,
10-11 MAY 2007

Giovanni says: "I love this area of sky because in a 4x4° field of view you can see a lot of different types of celestial object: red and blue stars; globular clusters; and reflection, emission and dark nebulae. It's a fantastic and unique ensemble: really the perfect field."

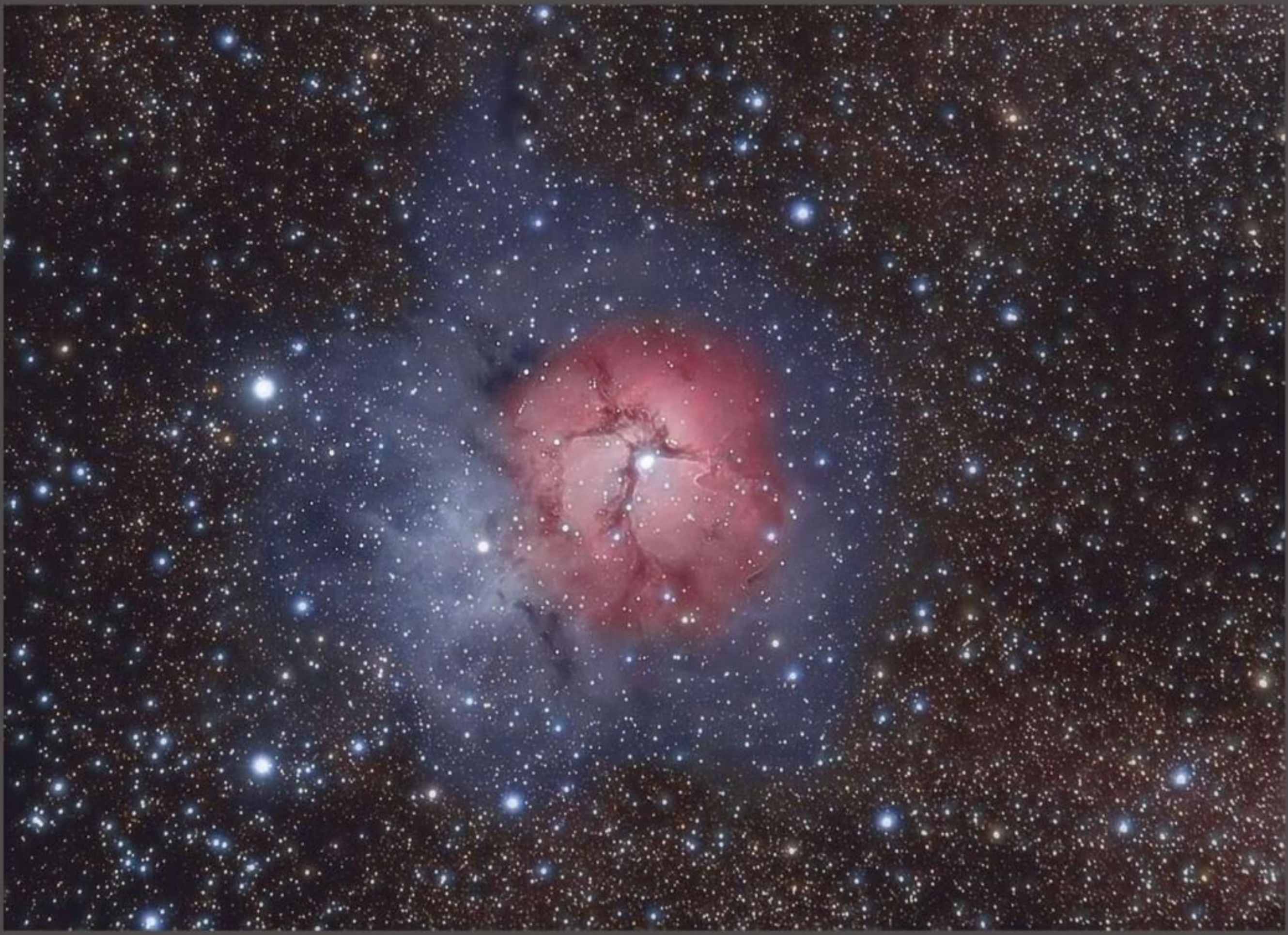
Equipment: Finger Lakes Instrumentation ProLine 16803 CCD camera, Takahashi FSQ-106 refractor.

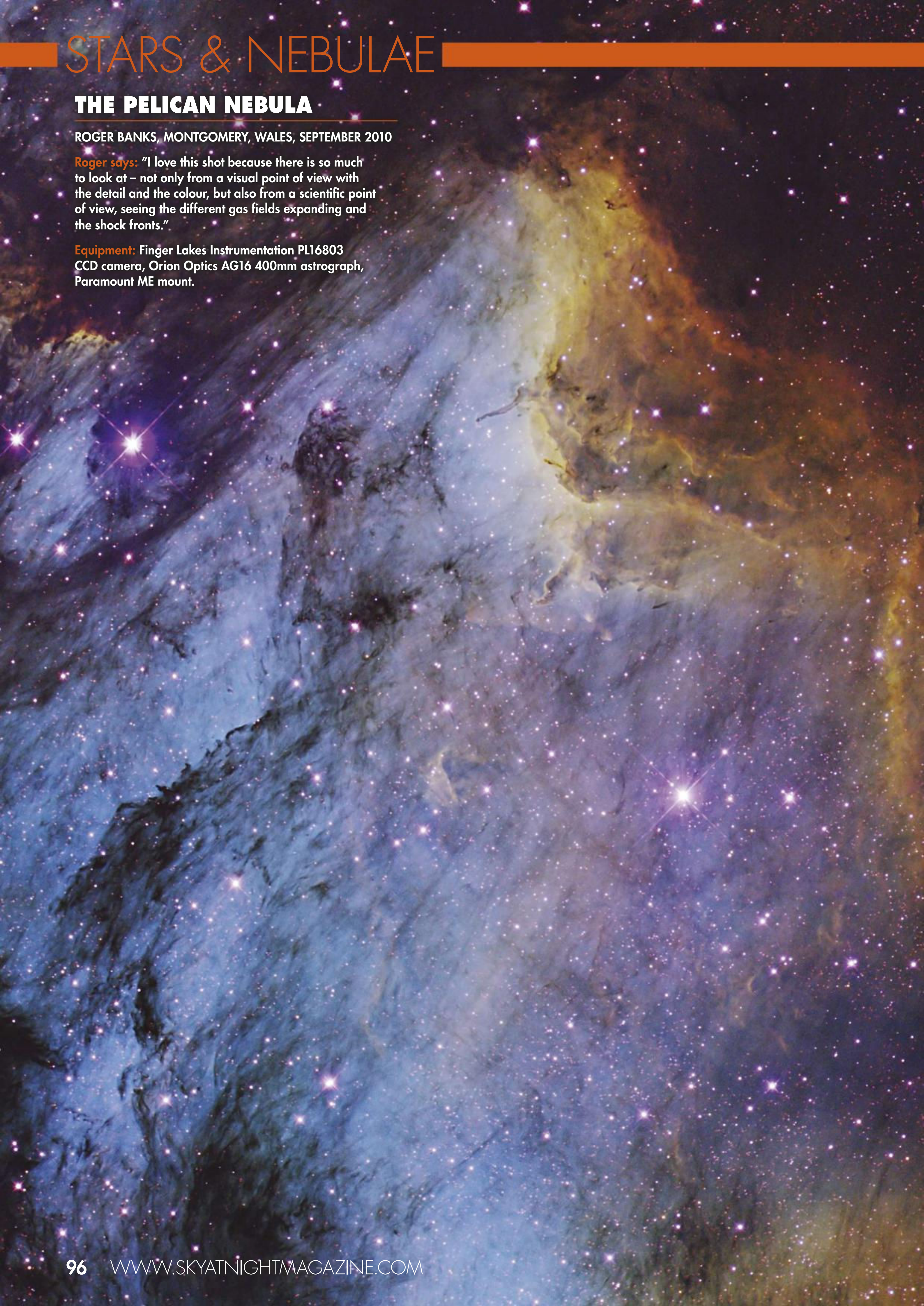
▼ M20, THE TRIFID NEBULA

TOMMI WORTON AND IAN KING, LA PALMA,
28 JULY 2006

Tommy says: "This image is a collaboration between my good friend Ian King and myself. The data was captured by Ian and I did all the processing using Maxim DL and Photoshop CS."

Equipment: Starlight Xpress SXV-H9 CCD camera, 90mm William Optics telescope.





THE PELICAN NEBULA

ROGER BANKS, MONTGOMERY, WALES, SEPTEMBER 2010

Roger says: "I love this shot because there is so much to look at – not only from a visual point of view with the detail and the colour, but also from a scientific point of view, seeing the different gas fields expanding and the shock fronts."

Equipment: Finger Lakes Instrumentation PL16803 CCD camera, Orion Optics AG16 400mm astrograph, Paramount ME mount.

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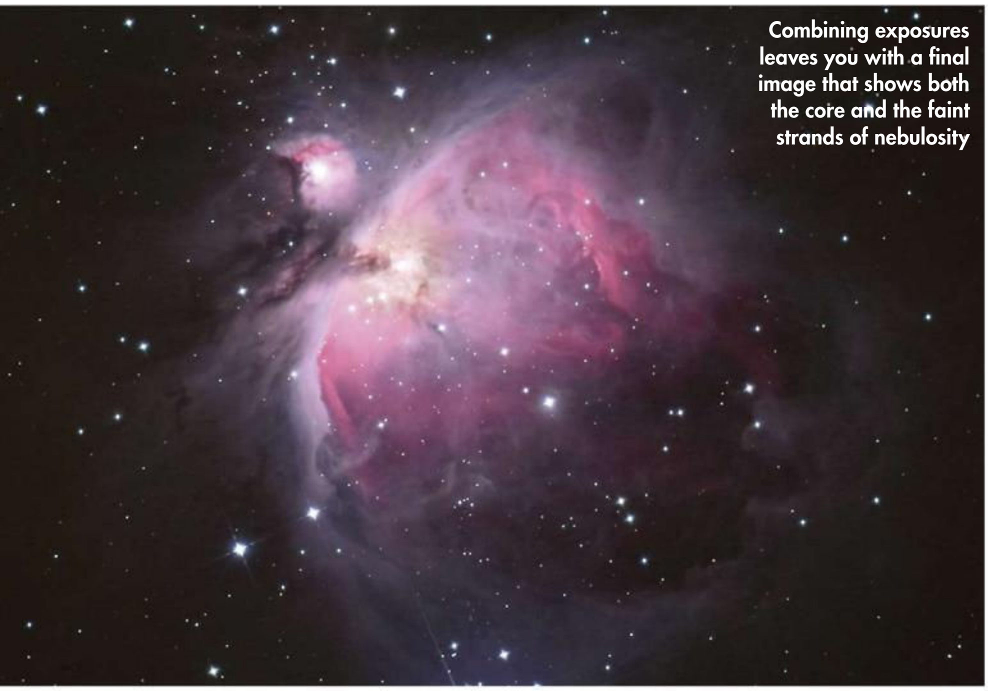
ASTROPHOTOGRAPHY TUTORIAL

WORDS: PETE LAWRENCE

THE ORION NEBULA



Combining exposures leaves you with a final image that shows both the core and the faint strands of nebulosity

RECOMMENDED EQUIPMENT

DSLR camera, 500mm lens, equatorial tracking mount, shutter release cable

The region of sky known as Orion's Sword is still a favourite port of call. In a sky where faint objects abound, there's something rather reassuring about the heart of the sword, marked by that most famous of deep-sky objects: the Orion Nebula, M42.

In many ways M42 is regarded as an easy object to image. Even a camera with a normal lens on a simple tripod will record its distinctly reddish glow, although unmodified DSLRs tend to give the incorrect impression that M42 is more purple than red.

You'll need a DSLR or CCD camera and a telescope to record M42 with a good image scale. The surrounding sword is larger – remember, M42 is just part of it – but can be captured with a 500mm lens as long as you vertically align the frame with the long axis.

Many imagers' initial attempts at capturing M42 involve short exposures. The fact that you can record something without having to use complicated lengthy exposures is something of a relief and many stop at this first image. However, there is more to be had. Shorter exposures record the core of the nebula, a region known as the 'Thrust'. This contains the small but distinctive Trapezium Cluster, estimated to have formed just 300,000 years ago. The strong ionising radiation from the cluster's stars is the reason why the Orion Nebula glows the way it does.

The surrounding bright Thrust region is mottled in texture and is easy to lose in longer exposures, which are necessary to investigate the beautiful tendrils of gas that spread away from the Thrust. Here you'll find two prominent features known as the 'Sail' and (confusingly) the 'Sword'. In this case, the Sword is the southeast tendril with a sharp edge to it.

These two regions arc around and eventually reconnect. This extended loop is fainter than the main part of M42, and considerably harder to record.

As you start to pull out the whole of the loop, it becomes obvious that its interior is also full of nebulosity. A dark indented part of the kidney-shaped Thrust also becomes quite noticeable – a region of the nebula called the 'Fish's Mouth'. Longer exposures also start to show the fainter M43 nebula, a comma-shaped region of nebulosity separated from the Thrust by a dark lane of gas. M43 has some lovely sharp edges thanks to these interloping dark lanes.

Overexposure

However, pulling out the fainter parts of the region results in an overexposed blob where the delicately mottled Thrust should be. There's something rather uncomfortable in reducing the beauty of this region to nothing more than a white patch – it just feels wrong – but remember while you're doing it that it can be reliably dealt with.

The correction process is actually quite straightforward but it does take a bit of discipline. First, remember not to fret over the deliberate sacrifice of one part of an image for another. Then don't forget to take the exposures that will correct the situation. Taking a series of images that will overexpose the centre is a waste if you forget to take a set of short exposures to record the core.

If your field of view is wide enough to capture the star cluster immediately to the north of M42, longer exposures will reveal a blue reflection nebula known as NGC 1977. Dark lanes cross this glowing region, like a ghostly figure racing across the cloud. For this reason, it is also known as the Running Man Nebula.

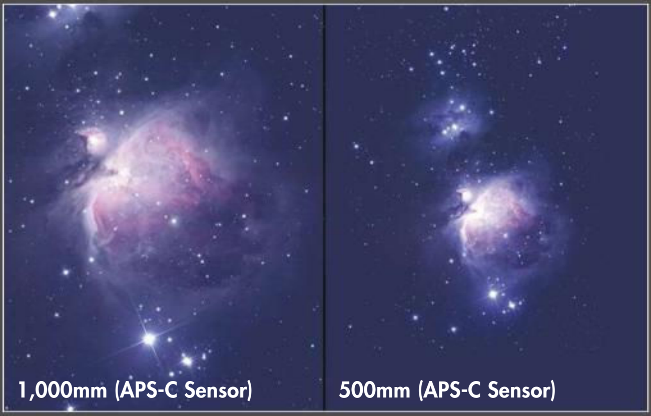
Follow the process opposite and see just how deep you can go into the magnificent Orion Nebula. You'll need to use a DSLR camera fitted with a lens or attached to a telescope with a focal length of 500mm or longer. The arrangement will also need to be on a driven mount, to permit you to capture the long exposures without features trailing across the image.

KEY TECHNIQUE

Orion's Sword contains faint nebulae as well as one unusually bright one – M42. This poses a challenge because the longer exposures needed to grab the fainter, delicate tendrils of glowing gas that permeate the region will invariably overexpose the core of M42. You can address this issue using layer masks – these allow you to have the best of both worlds – combining both faint and bright regions to produce a stunning high dynamic range image that shows off the Orion Nebula at its best.

ALL PICTURES: PETE LAWRENCE

STEP BY STEP GUIDE



1,000mm (APS-C Sensor) 500mm (APS-C Sensor)

STEP 1

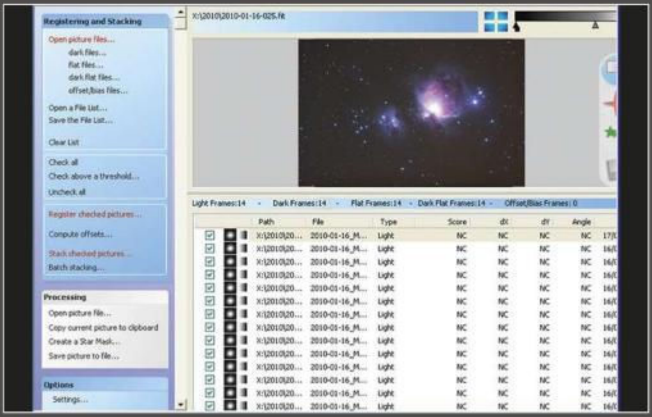
Your first decision is to decide how close to M42 you want to get. Longer focal lengths increase image scale but need more accurate alignment and driving. Coupling a DSLR to a scope is a good way to get a decent magnification. Around 1,000mm focal length will give a comfortable scale with lots of detail if available.

STEP 2

Keeping the ISO setting of your camera away from maximum will reduce noise and give your image better tonal resolution. Anywhere between ISO 200-800 is probably about right. Poor mount accuracy leading to star trailing may limit exposure times; in this case, a higher ISO may be used at the expense of image quality.

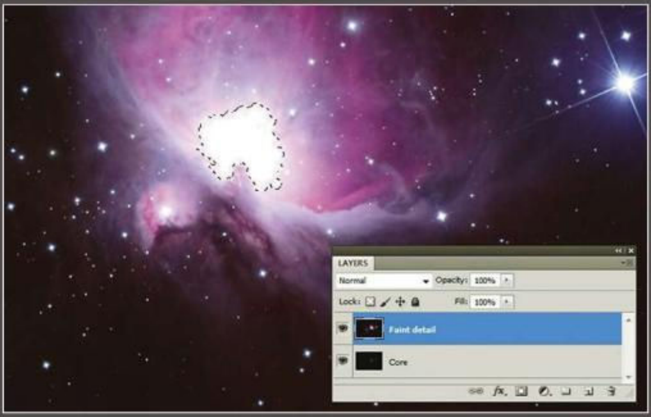
STEP 3

Take a set of 16 15-second shots, then the same at 30, 60, 90 and 120 seconds (longer if mount accuracy permits). After each set, cap your lens or scope and take nine dark frames. Take flat-fields by pointing your setup at an evenly lit light source. Expose so the image histogram shows peak saturation of 0.5-0.75 towards white.



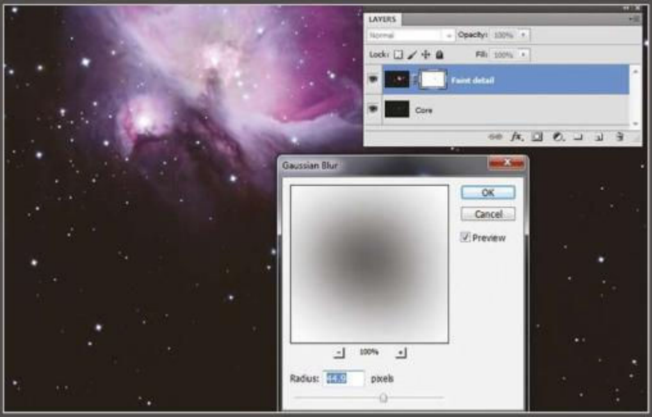
STEP 4

An image processing application such as DeepSkyStacker can process matching light, dark and flat-field images. One set of flats works for all exposure groups. Follow the software's instructions and process each exposure set to a final image. Load each into a separate layer in a graphics editor such as Photoshop or GIMP.



STEP 5

Process each layer to taste using the Levels and Curves tools. Pick a result showing good outer detail and one exposed for the core. Duplicate, and bring these to the top of the layer list, with the most detailed on top. Align and create a selection of the overexposed core in the top image.

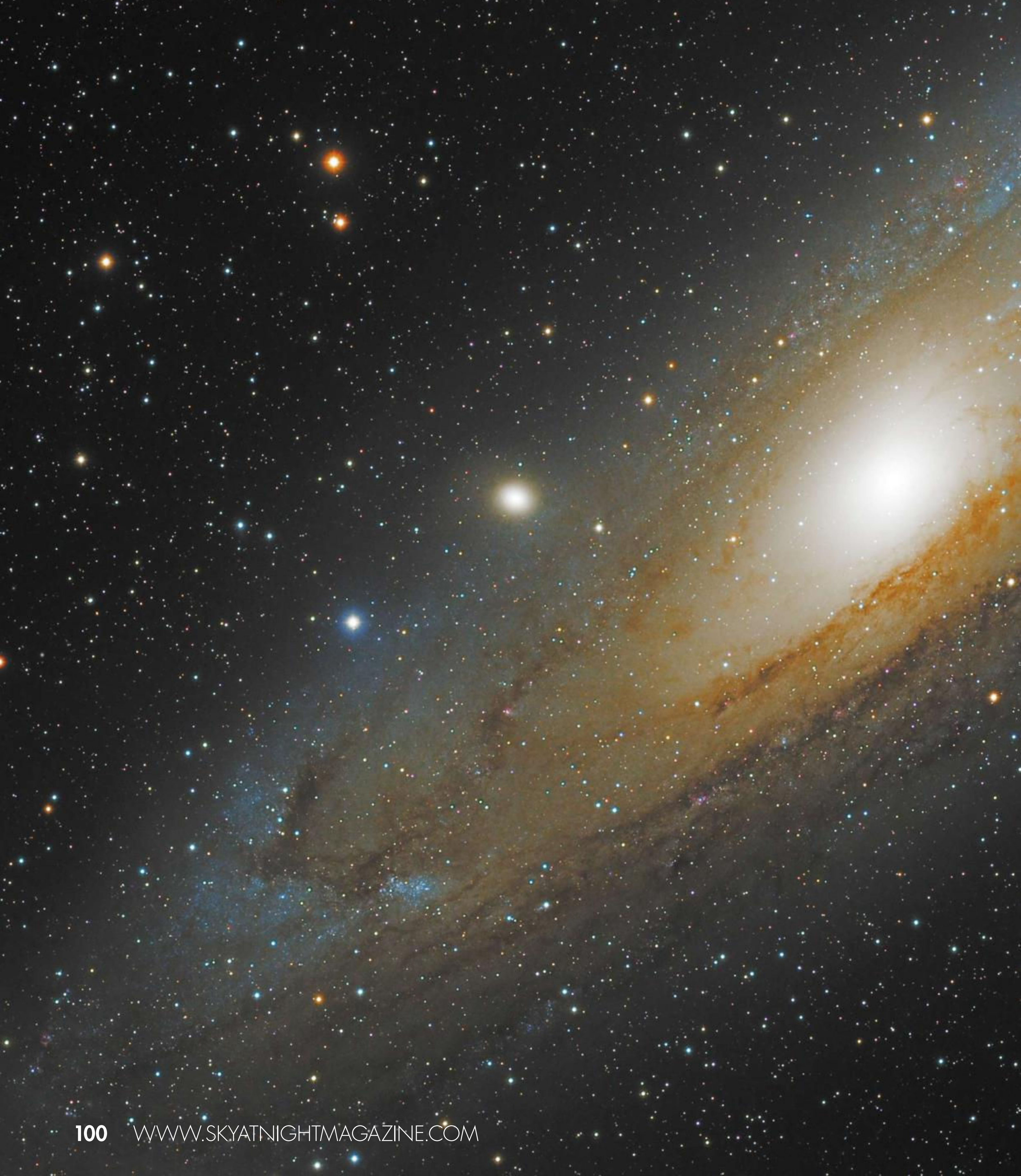


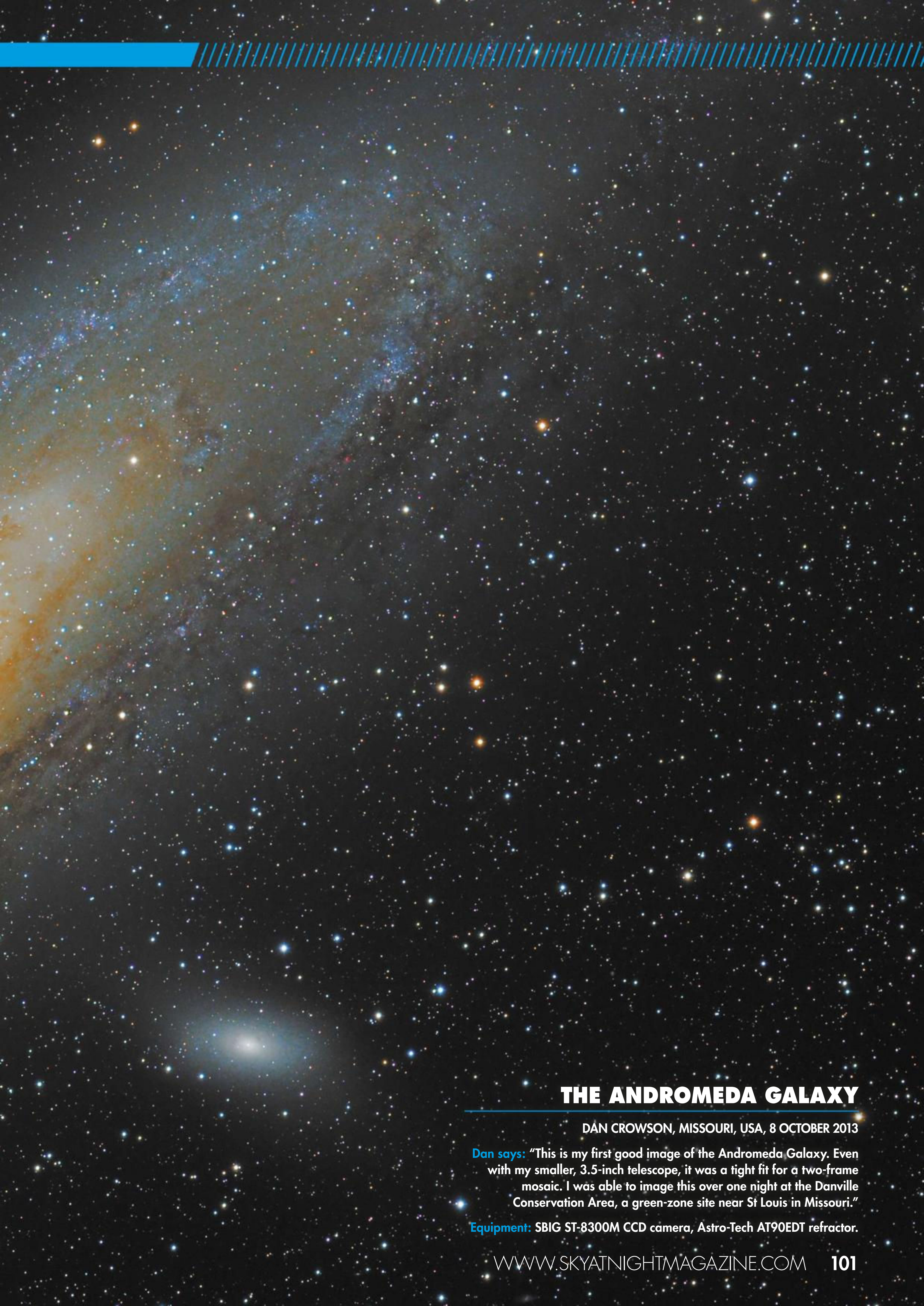
STEP 6

Copy the selection and paste it as a layer mask. The dark part of the mask allows the lower image through, white blocks it. Select the mask and apply a Gaussian blur to soften the sharp mask edges. This should result in the detailed upper image blending into the lower image exposed for the core. Merge the layers and save.

GALAXIES

Untold billions of stars held together by gravity, galaxies are some of the most beautiful objects in the night sky, be they winding spirals or glowing ellipses. The problem is, they tend to be a long way away and, despite their enormous sizes, this means you'll almost certainly need a telescope to get a photo of one. If you've got the necessary equipment, then photographing galaxies can lead to some stunning images. It also opens up a world of image processing, as stacking of multiple exposures, including flat frames and dark frames, can be used to bring out detail in the galaxies such as glowing centres or dark dust lanes in the edges.



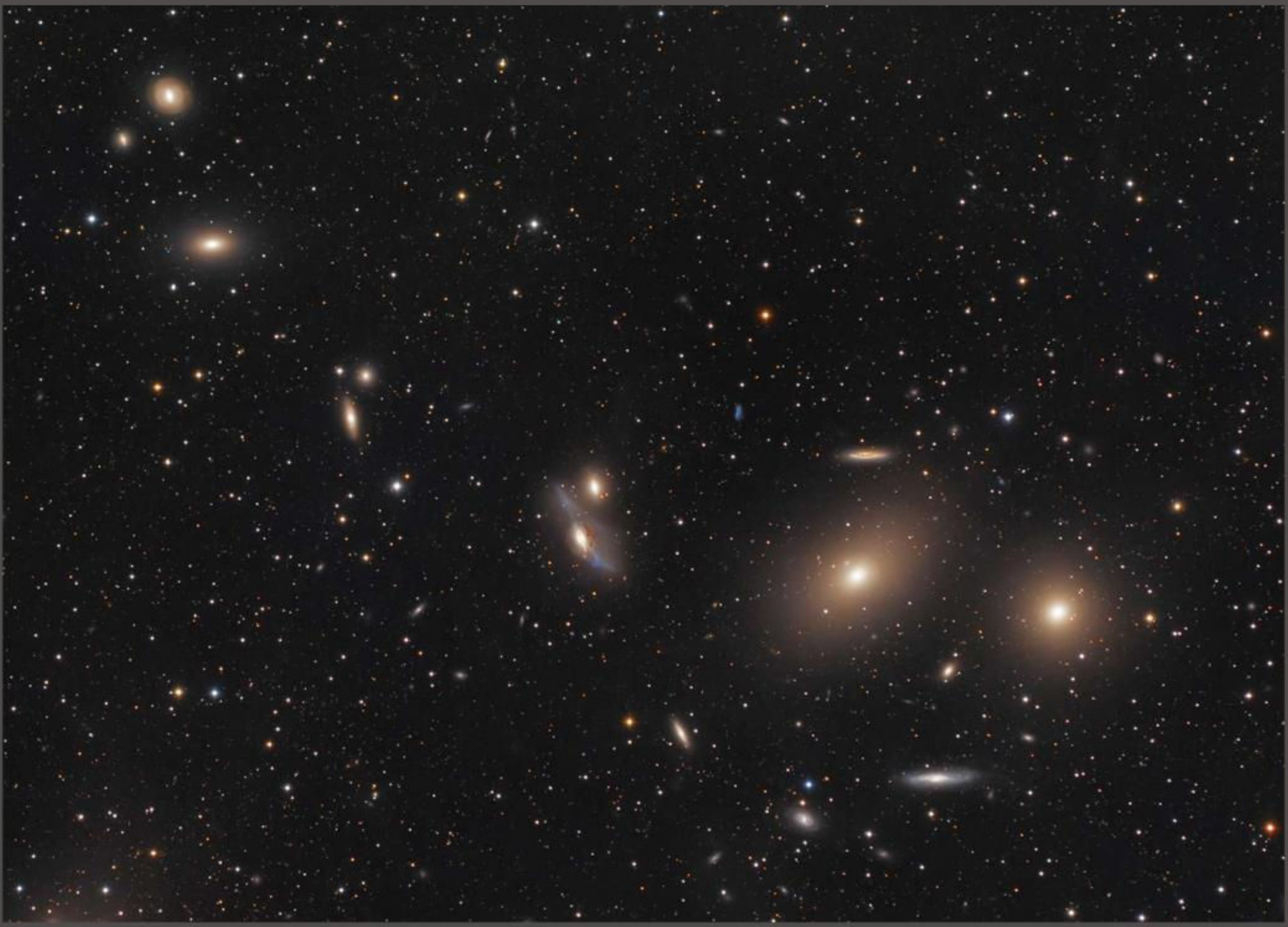


THE ANDROMEDA GALAXY

DAN CROWSON, MISSOURI, USA, 8 OCTOBER 2013

Dan says: "This is my first good image of the Andromeda Galaxy. Even with my smaller, 3.5-inch telescope, it was a tight fit for a two-frame mosaic. I was able to image this over one night at the Danville Conservation Area, a green-zone site near St Louis in Missouri."

Equipment: SBIG ST-8300M CCD camera, Astro-Tech AT90EDT refractor.



▲ MARKARIAN'S CHAIN OF GALAXIES

BOB FRANKE, ARIZONA, USA, 14 MARCH 2013

Bob says: "In this case, the hand of gravity created a wonderful composition. The galaxies present a beautiful arc from left to right, with the sizes generally increasing."

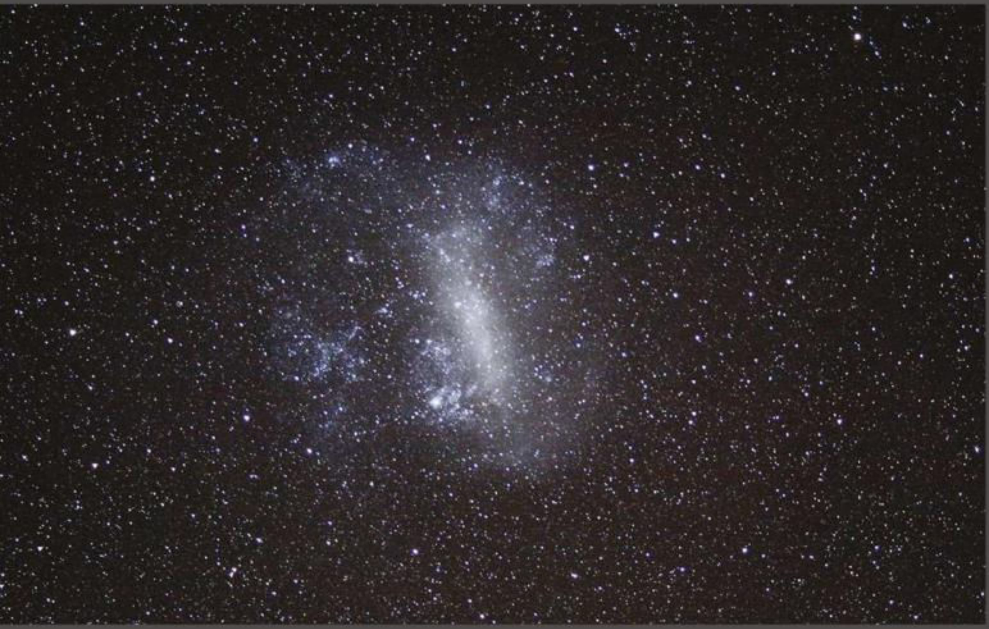
Equipment: SBIG STF-8300 CCD camera, Takahashi FSQ-106ED refractor.

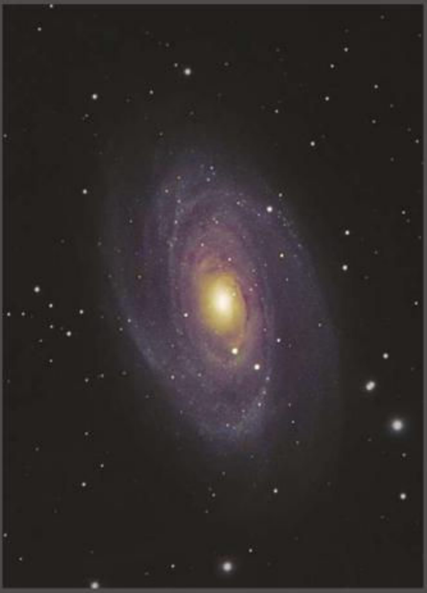
▼ THE LARGE MAGELLANIC CLOUD

TONY SURMA-HAWES, LINVILLE, QUEENSLAND, AUSTRALIA, 10 AUGUST 2007

Tony says: "I took this at the Queensland Astrofest star party. I'm impressed with how the lens captured the halo around the bar."

Equipment: Canon EOS 400D DSLR camera, 18-55mm lens.



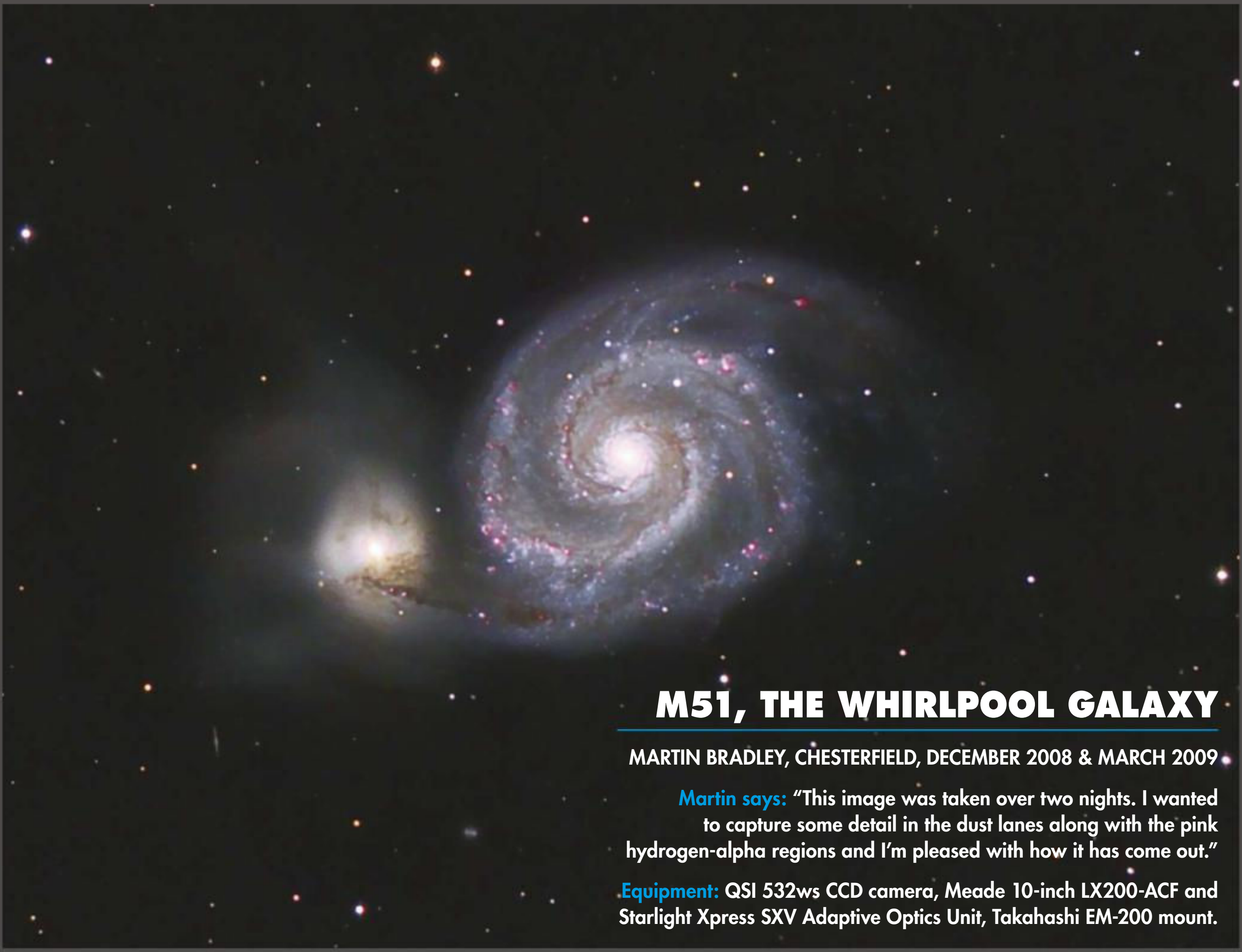


▲ BODE'S GALAXY

STEPHEN DEAN, ISLE OF WIGHT, 19 DECEMBER 2014

Stephen says: "This is my first attempt at photographing a galaxy with a CCD camera and I'm quite pleased with the result. It is made up of about 4.5 hours of sub-exposures."

Equipment: SBIG ST-2000XM CCD camera, Sky-Watcher 3-inch ED Pro telescope, NEQ6 mount.

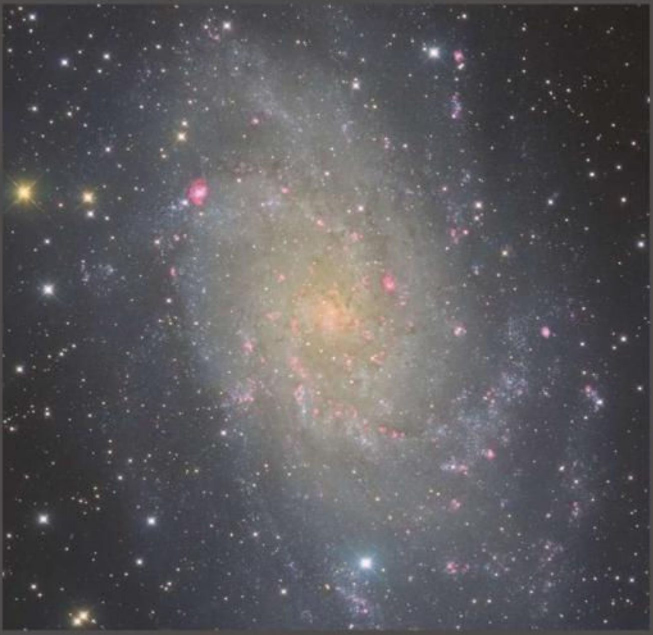


M51, THE WHIRLPOOL GALAXY

MARTIN BRADLEY, CHESTERFIELD, DECEMBER 2008 & MARCH 2009

Martin says: "This image was taken over two nights. I wanted to capture some detail in the dust lanes along with the pink hydrogen-alpha regions and I'm pleased with how it has come out."

Equipment: QSI 532ws CCD camera, Meade 10-inch LX200-ACF and Starlight Xpress SXV Adaptive Optics Unit, Takahashi EM-200 mount.



▲ THE TRIANGULUM GALAXY

SCOTT FINDLAY, FRANCE, 5 SEPTEMBER 2014

Scott says: "The addition of hydrogen-alpha helps to highlight some of the more interesting areas of M33, as well as bringing out some of the faint nebulosity just to the right of NGC 588 in the image."

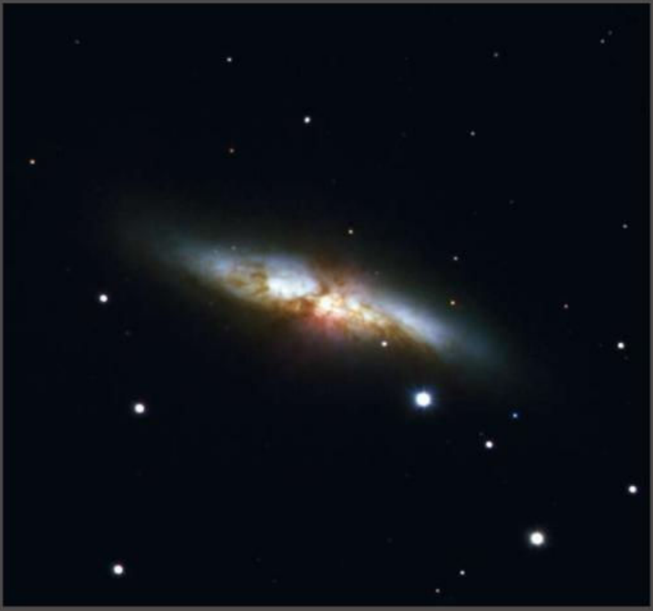
Equipment: FLI Microline ML8300 CCD camera, 12-inch ASA Newtonian telescope, ASA DDM85 mount.

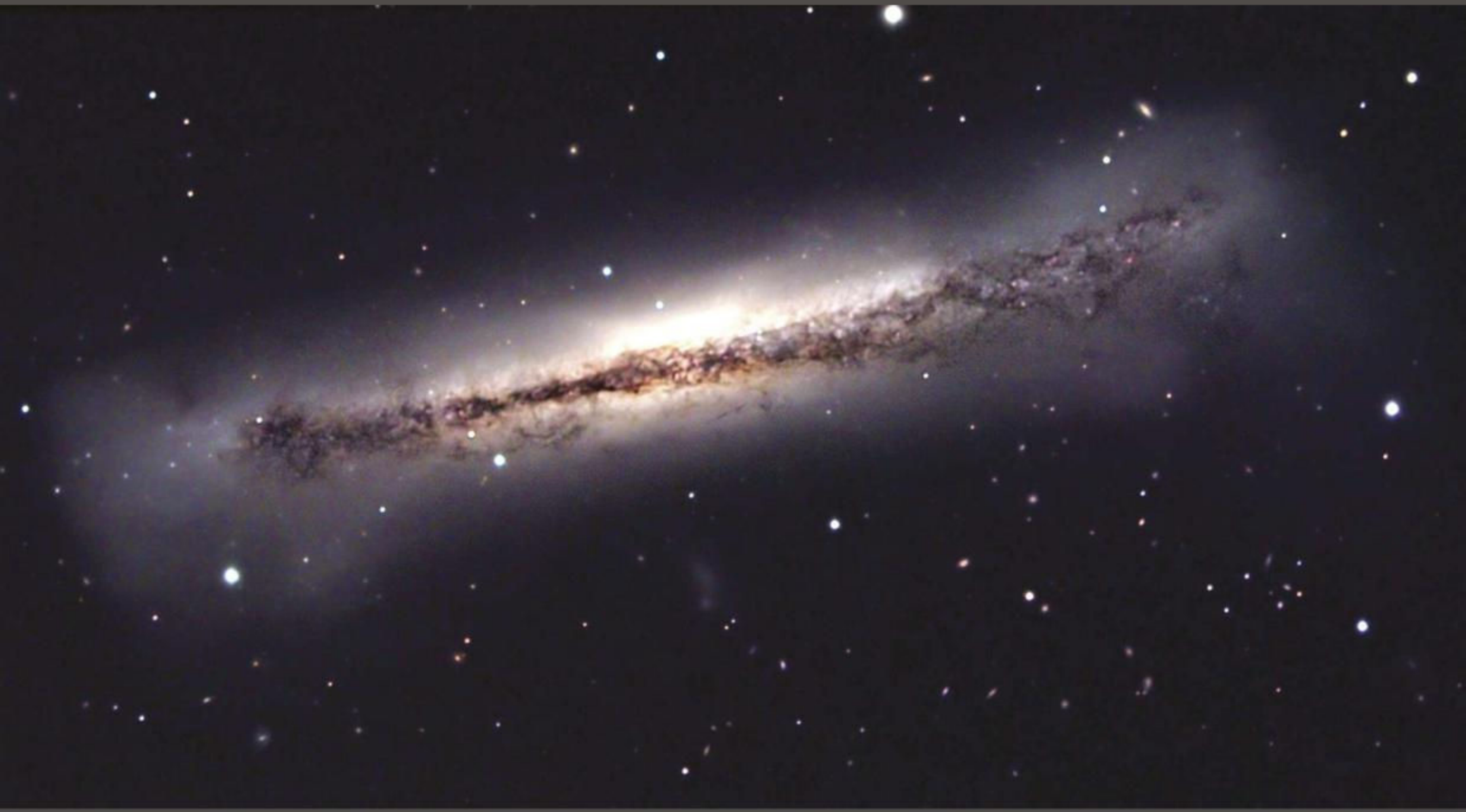
▼ M82, THE CIGAR GALAXY

JOHN WELSH, HUYTON, LIVERPOOL, 22–23 JANUARY 2007

John says: "I'm pleased with the roundness of the stars and the general contrast, but it's a bit noisier than expected. Next time I'll try longer colour exposures and include some H-alpha shots to bring out the red more."

Equipment: Starlight XPress SXV-H9 CCD camera, 300mm f/5.3 reflector telescope.



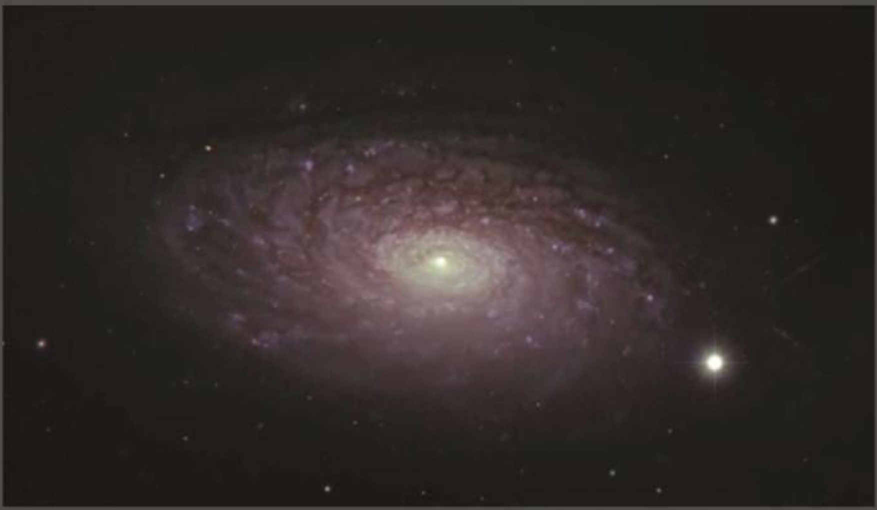


▲ NGC 3628, THE HAMBURGER GALAXY

PETER VASEY, NORTHUMBERLAND, MARCH 2010

Peter says: "NGC 3628 in Leo is usually imaged along with Messier 65 and 66 as part of the well-known 'Leo Trio'. But its extensive dust lanes and scattered clouds of stars make it well worth imaging on its own."

Equipment: Santa Barbara Instrument Group ST-10XME CCD camera, Meade LX200 ACF Schmidt-Cassegrain telescope, AO-8 adaptive optics system, Gemini G41 mount.



▲ M63, THE SUNFLOWER GALAXY

ROB HODGKINSON, WEYMOUTH, DORSET, MAY/JUNE 2008

Rob says: "This image was a bit of a struggle. It took about a month to get the sub-exposures for this, including most of May and a little of June, due to our wonderful weather. I was sick of looking at it by the time I'd finished!"

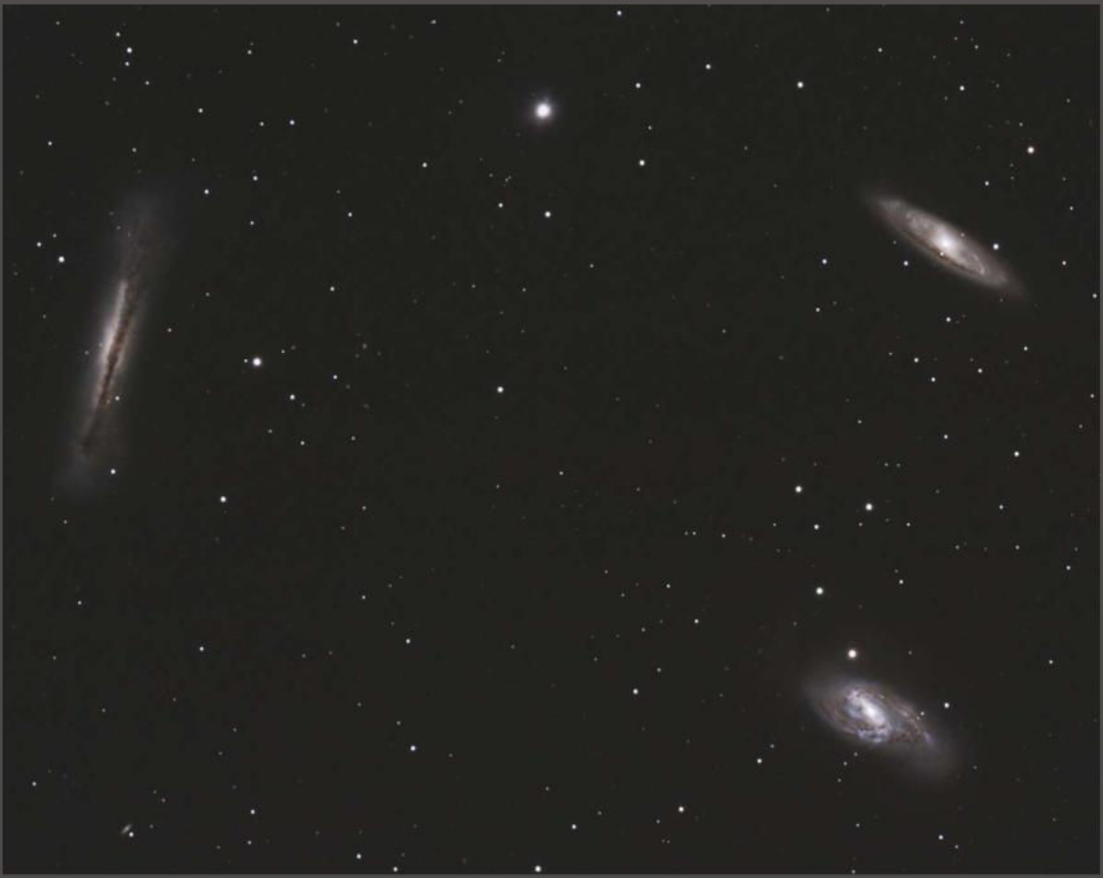
Equipment: Atik 16 HRC CCD camera, 14-inch LX200 GPS, Tal 100R, Meade DSI Pro.

THE NEEDLE GALAXY

MARK GRIFFITH, SWINDON,
23 MARCH 2014

Mark says: "This is an edge-on view of the Needle Galaxy [NGC 4565] in the constellation of Coma Berenices. I captured some colour: slight blues on the far edges, showing new star-forming regions and old yellow stars at the core. Prominent dust lanes stretch along the length of the galaxy."

Equipment: QHY8L one-shot colour CCD camera, Teleskop Service 65 Quad apo telescope, iOptron iEQ45 mount.



◀ THE LEO TRIPLET

GEDAS VYSNIAUSKAS, INDIANA, USA; 20 MARCH 2009

Gedas says: "I really like the way that all three galaxies just fit within the field of view of my camera/scope combination. Each is so unique and full of detail; they are really neat to study."

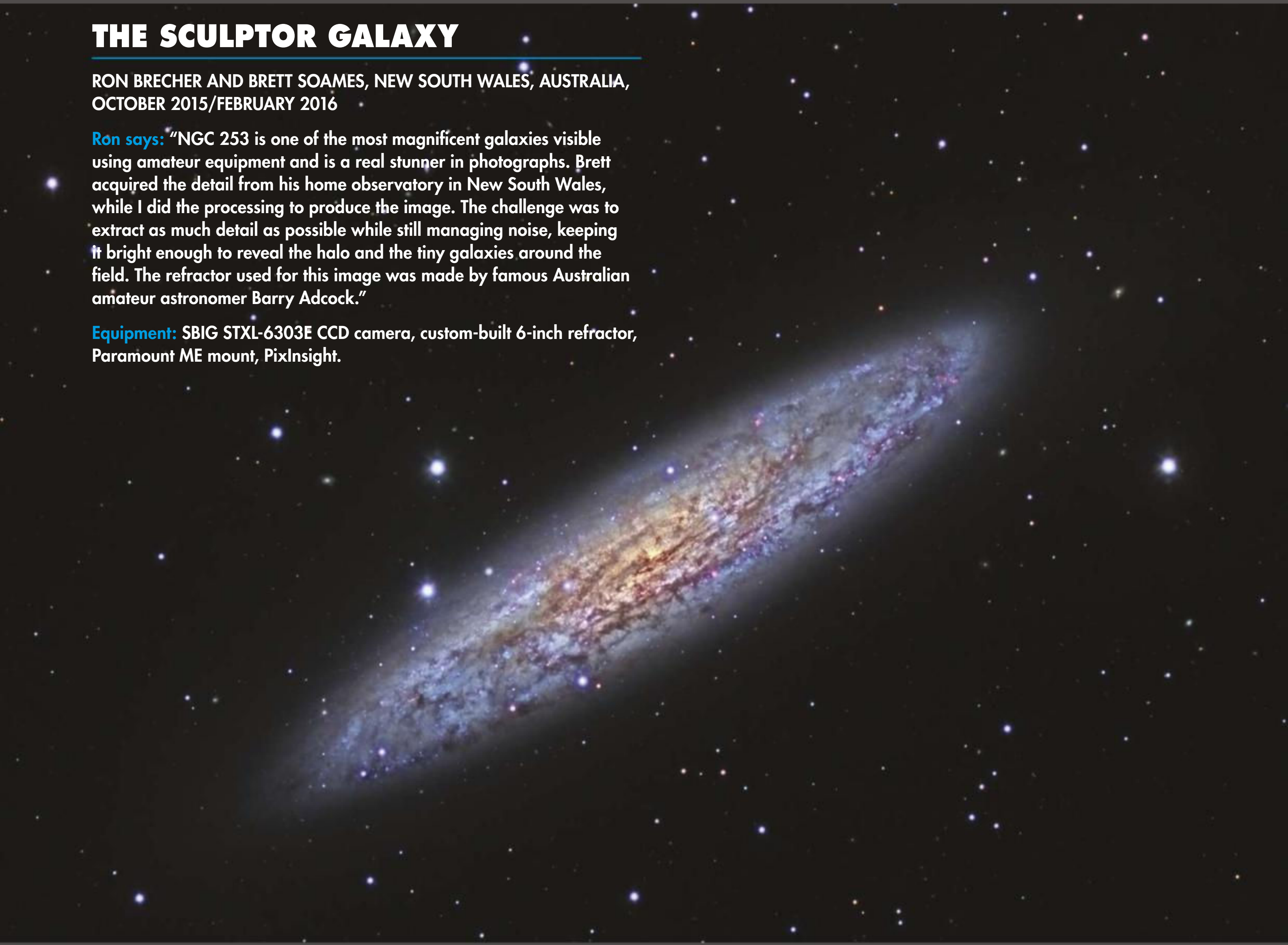
Equipment: Canon EOS 450D DSLR camera, TEC APO 140 refractor, Astro-Physics 900 German Equatorial mount.

THE SCULPTOR GALAXY

RON BRECHER AND BRETT SOAMES, NEW SOUTH WALES, AUSTRALIA, OCTOBER 2015/FEBRUARY 2016

Ron says: "NGC 253 is one of the most magnificent galaxies visible using amateur equipment and is a real stunner in photographs. Brett acquired the detail from his home observatory in New South Wales, while I did the processing to produce the image. The challenge was to extract as much detail as possible while still managing noise, keeping it bright enough to reveal the halo and the tiny galaxies around the field. The refractor used for this image was made by famous Australian amateur astronomer Barry Adcock."

Equipment: SBIG STXL-6303E CCD camera, custom-built 6-inch refractor, Paramount ME mount, PixInsight.

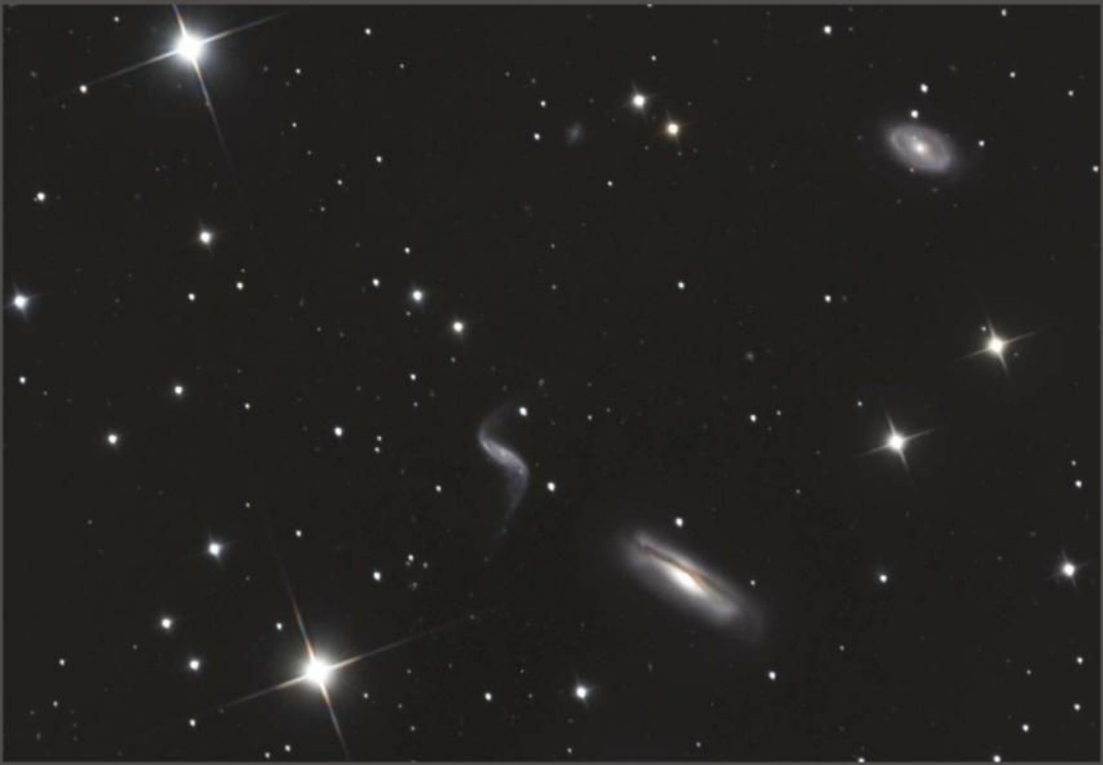


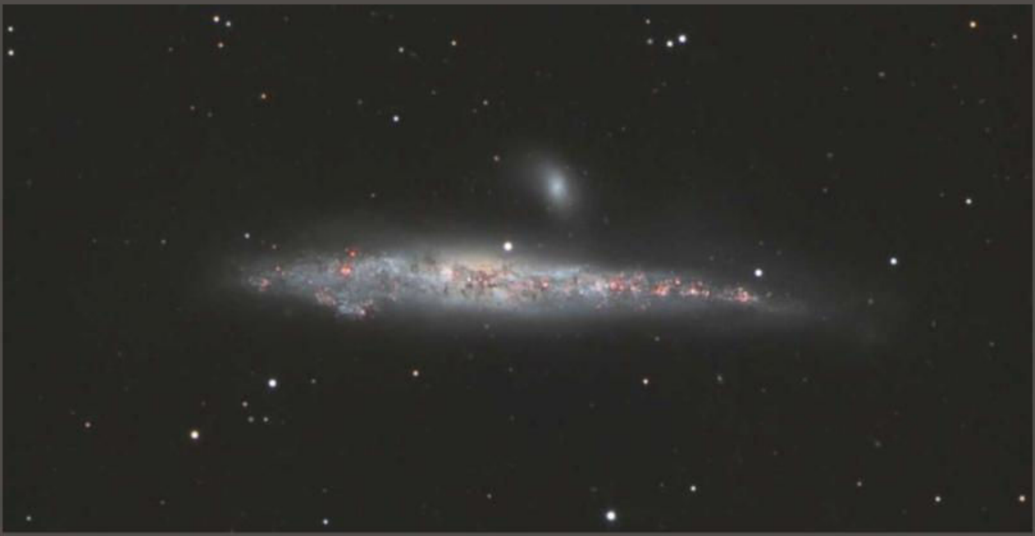
HICKSON 44 ▶

FRANÇOIS BERNIER, SOUTHERN FRANCE, 25 MARCH 2011

François says: "This picture was a challenge for me. This group of galaxies [NGC 3187, NGC 3185 and NGC 3190] is one of the most beautiful in Leo. It's surprising to see so many galaxies in the background."

Equipment: ATIK 314L CCD camera, Vixen VC200L catadioptric telescope.



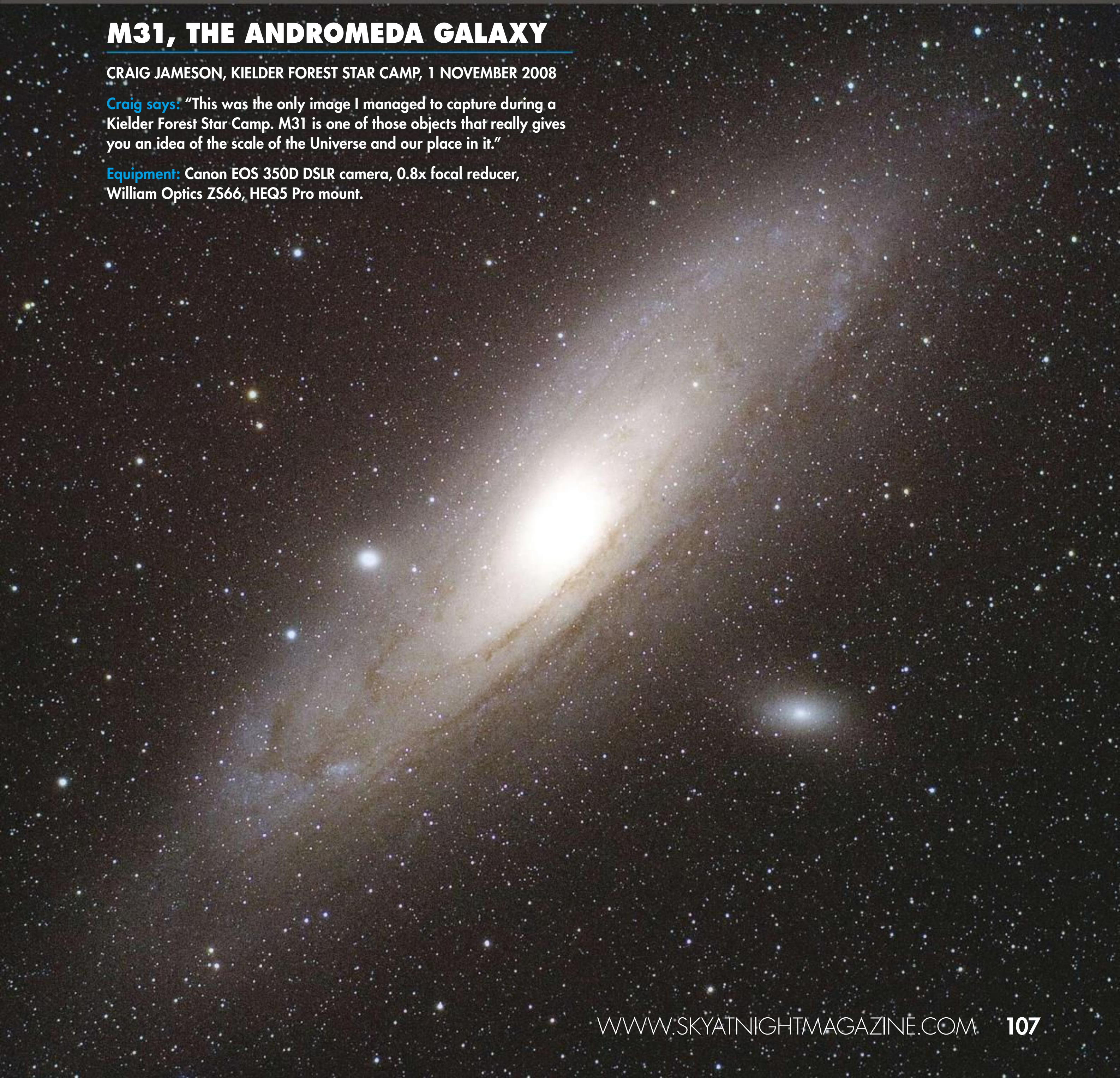


◀ NGC 4631

MIKE DEEGAN,
SWINDON, APRIL 2011

Mike says: "There is so much going on in this galaxy, from the red star-forming regions to the fine dust lanes crossing the core. The time spent collecting hydrogen-alpha data has really paid off in the final result."

Equipment: Starlight Xpress HX916 CCD camera, Sky-Watcher 250PX reflector, Sky-Watcher EQ6 mount.

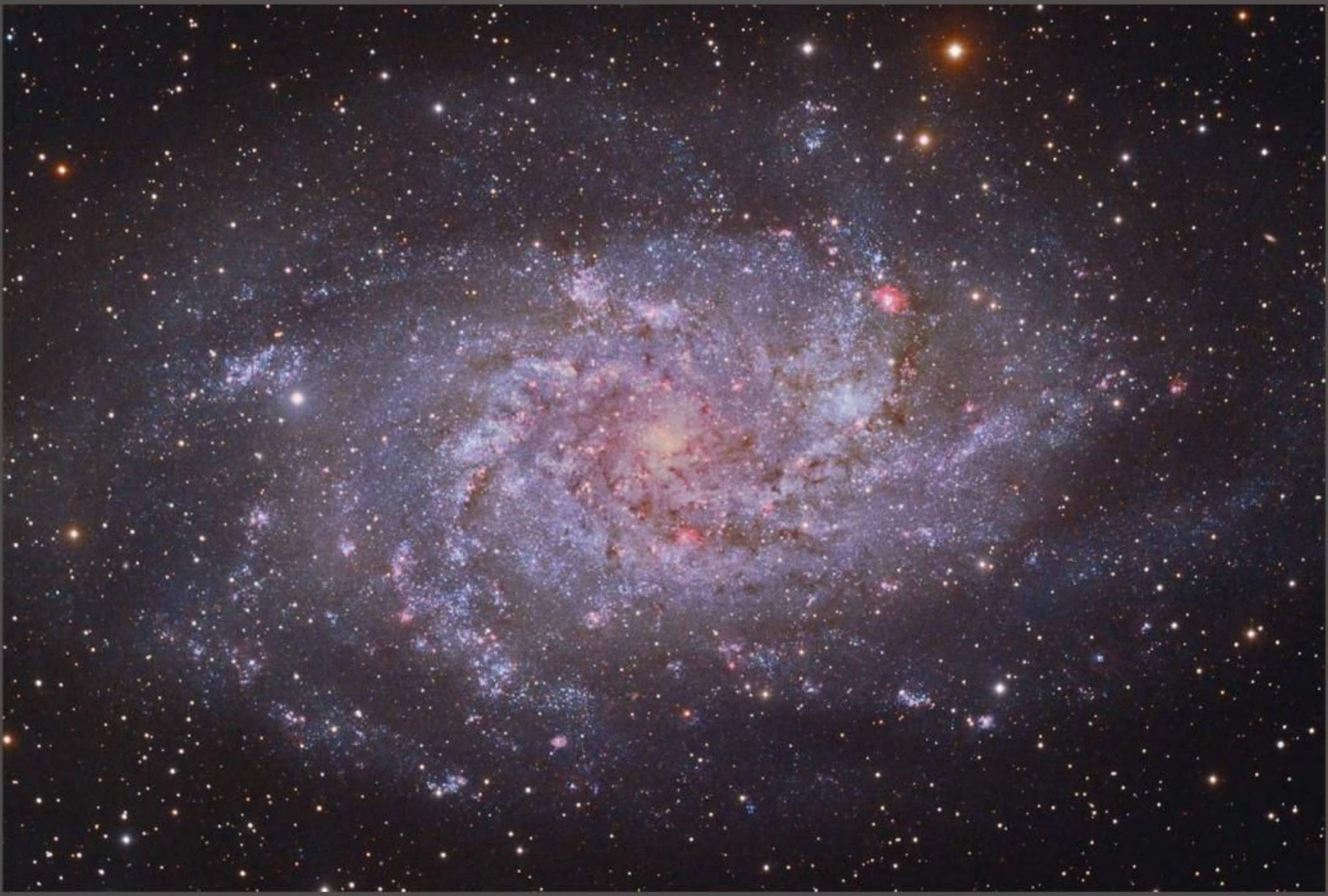


M31, THE ANDROMEDA GALAXY

CRAIG JAMESON, KIELDER FOREST STAR CAMP, 1 NOVEMBER 2008

Craig says: "This was the only image I managed to capture during a Kielder Forest Star Camp. M31 is one of those objects that really gives you an idea of the scale of the Universe and our place in it."

Equipment: Canon EOS 350D DSLR camera, 0.8x focal reducer, William Optics ZS66, HEQ5 Pro mount.



▲ M33, THE TRIANGULUM GALAXY

TERRY HANCOCK, MICHIGAN, USA, 7 OCTOBER 2011

Terry says: "It was my goal to go as deep as possible in order to capture the very faint outer spiral arms, the dusty regions and the colourful HII nebulae while trying to retain a natural appearance."

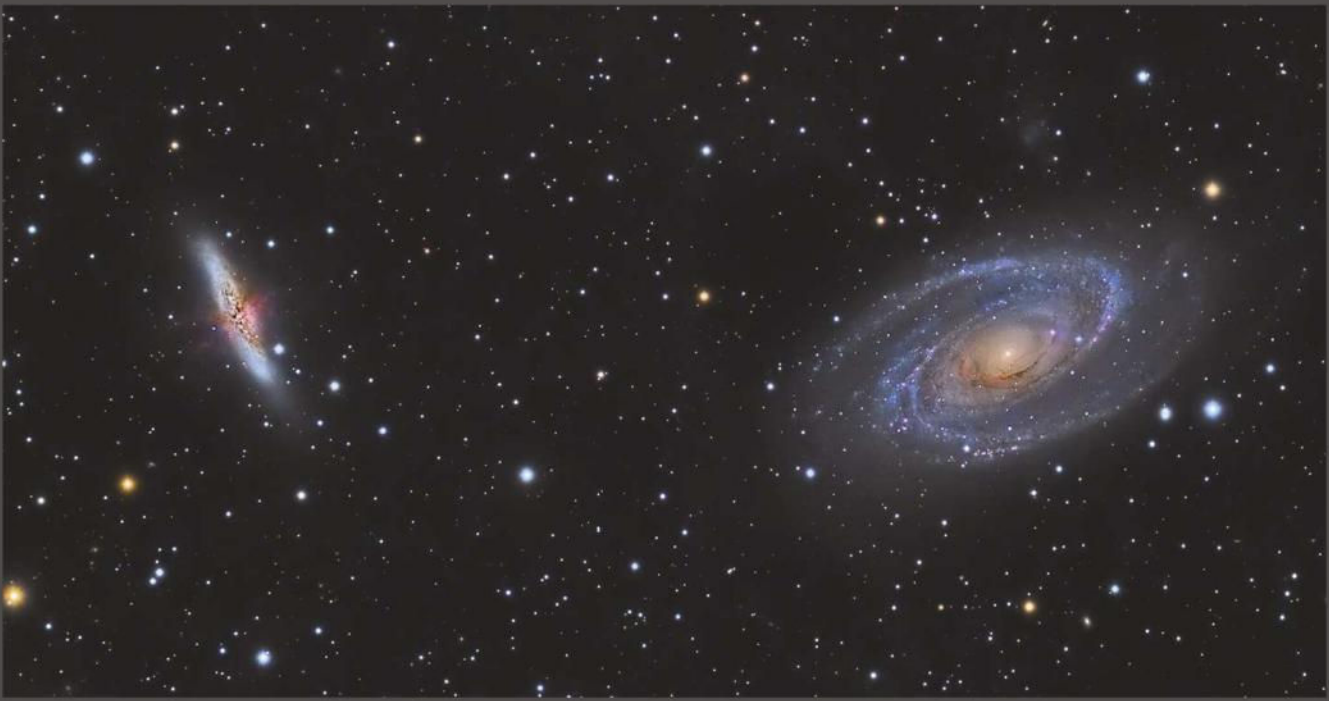
Equipment: QHY9M monochrome CCD camera, TMB-130SS refractor, Paramount GT-1100S, MKS4000 mount.

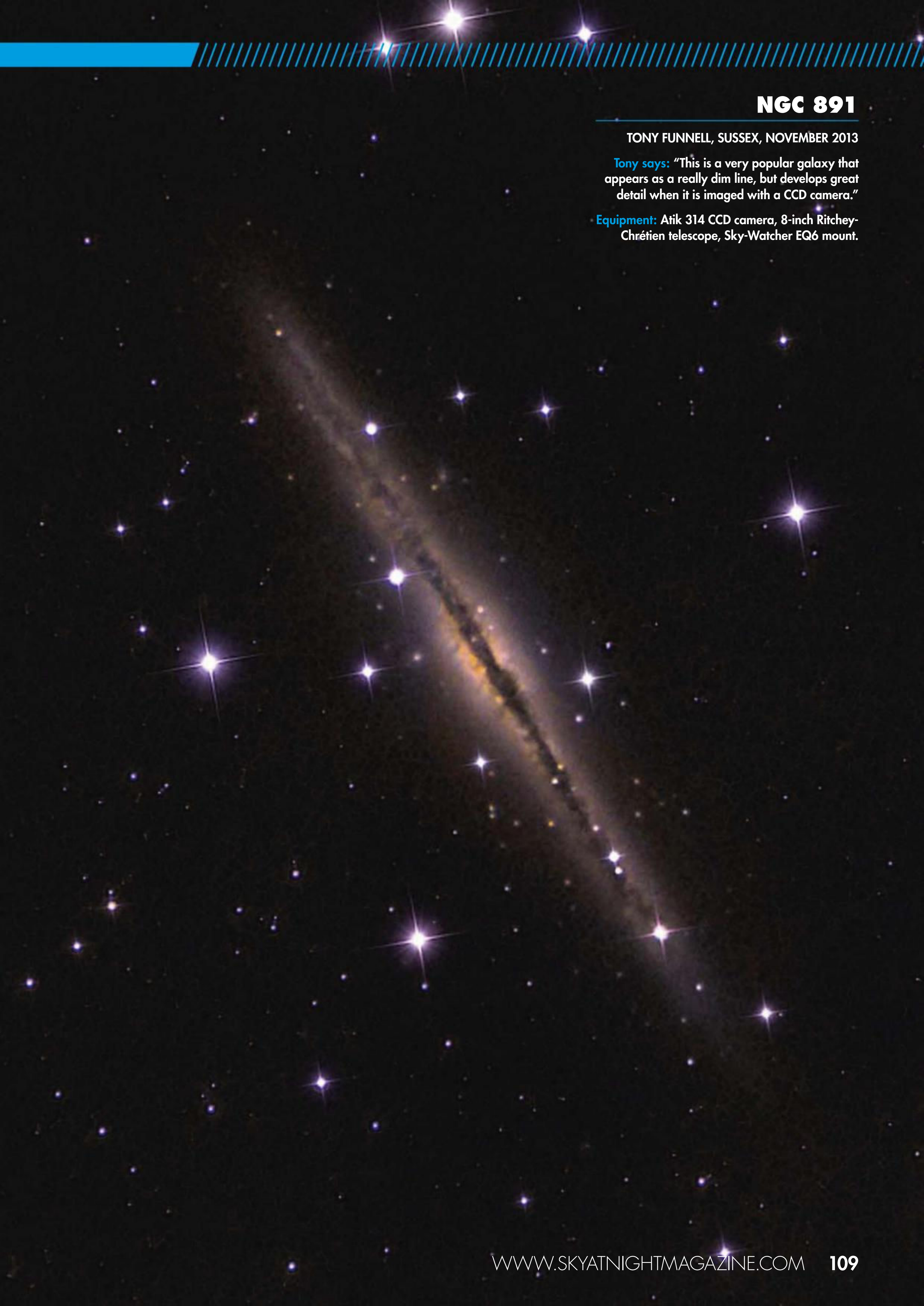
▼ M81 AND M82

ÁLVARO IBÁÑEZ PÉREZ, CORRAL DE ALMAGUER, TOLEDO, SPAIN, 25 MAY 2015

Álvaro says: "Corral de Almaguer is in the south of Madrid, so these objects are normally obscured and I had to use an anti-pollution filter. That evening everything turned out perfectly."

Equipment: Atik 460EX mono CCD camera, TS115 triplet apo refractor, NEQ Pro II tuning belts and EQMOD, Baader LRGB and IDAS LPS filters, GT-1100S with MKS4000 mount.



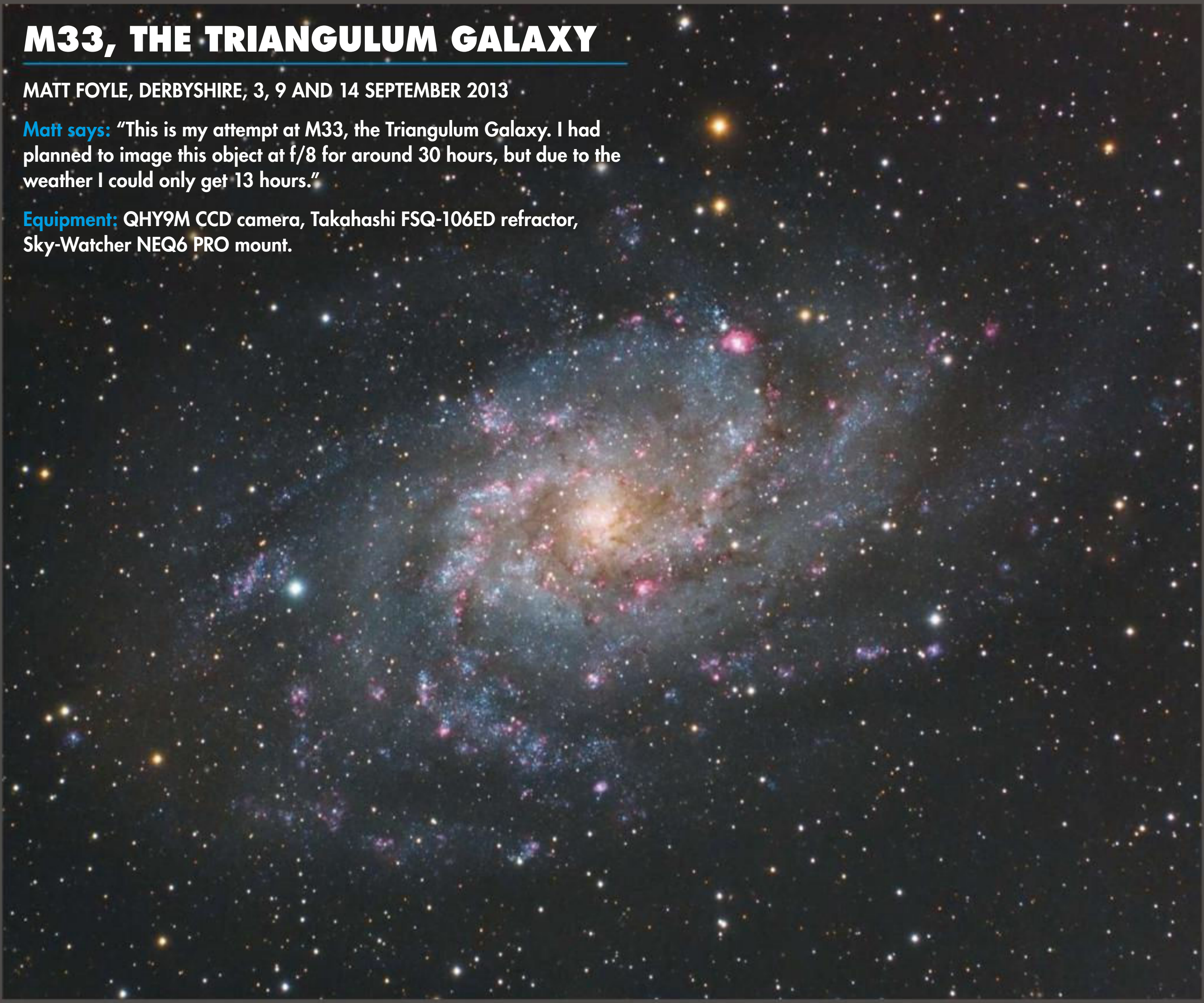


NGC 891

TONY FUNNELL, SUSSEX, NOVEMBER 2013

Tony says: "This is a very popular galaxy that appears as a really dim line, but develops great detail when it is imaged with a CCD camera."

Equipment: Atik 314 CCD camera, 8-inch Ritchey-Chrétien telescope, Sky-Watcher EQ6 mount.

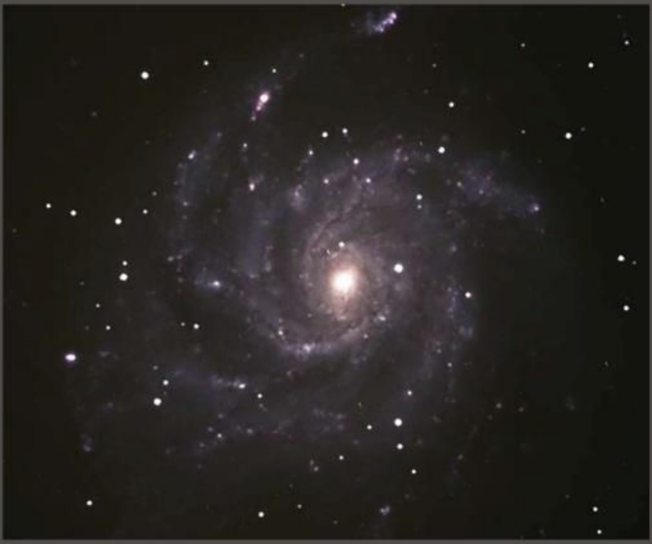


M33, THE TRIANGULUM GALAXY

MATT FOYLE, DERBYSHIRE, 3, 9 AND 14 SEPTEMBER 2013

Matt says: "This is my attempt at M33, the Triangulum Galaxy. I had planned to image this object at f/8 for around 30 hours, but due to the weather I could only get 13 hours."

Equipment: QHY9M CCD camera, Takahashi FSQ-106ED refractor, Sky-Watcher NEQ6 PRO mount.



▲ M101

DAVID HUGILL, MINETY, WILTSHIRE, APRIL 2008

David says: "I wanted to see if it was possible to maintain detail in the galaxy's faint arms without over-exposing the core with my Meade CCD camera."

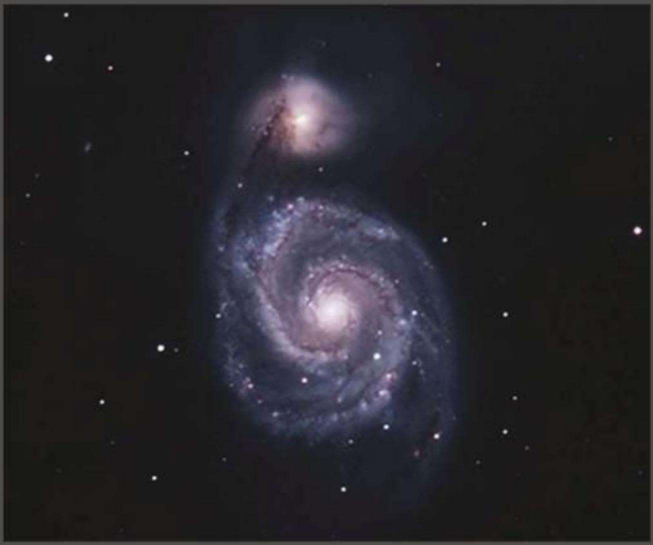
Equipment: Meade DSI-Pro 2 CCD camera, Meade LX90 telescope, Sky-Watcher ST80 autoguider.

▼ M51

IAN DUNBAR, NORTH HERTFORDSHIRE, 26 APRIL 2009

Ian says: "I've been imaging deep-sky objects for around a year now and this was my second image with my camera since I modified it by changing the stock IR filter to a Baader replacement filter."

Equipment: 10-inch Newtonian reflector, Canon EOS 450D DSLR camera, EQ6 Pro mount.

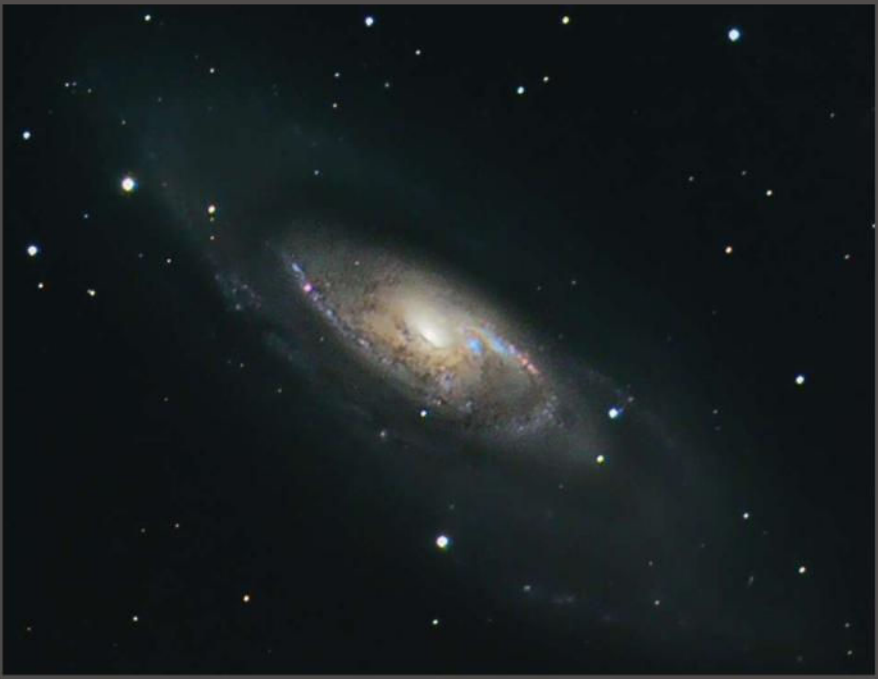


M106 ▶

ALAN CLITHEROW,
KIELDER FOREST
STAR CAMP,
MARCH 2012

Alan says: "The closer you look at this image, the more faint background galaxies you can pick out."

Equipment: Atik 314L monochrome CCD camera, Sky-Watcher 190MN DS-PRO Maksutov-Newtonian telescope, Celestron CGEM mount, Atik filter wheel, Astronomik LRGB CCD filters.

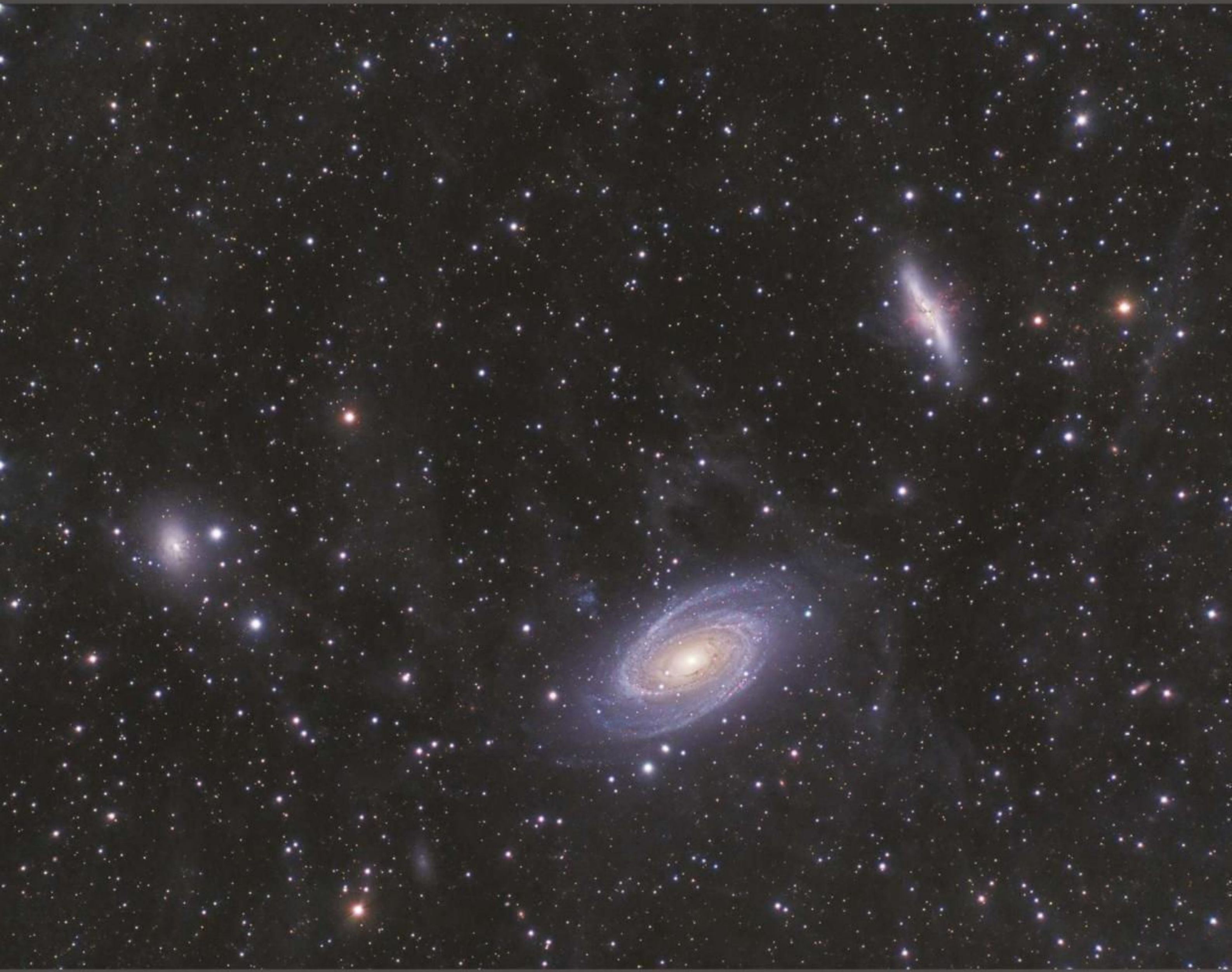


▼ M81 AND M82

FABIAN NEYER,
SWITZERLAND,
MARCH-MAY 2009

Fabian says: "This LRGB image combines 35 hours and 50 minutes of exposures. It shows the very faint Integrated Flux Nebula that spreads over the whole image in front of the M81 galaxies."

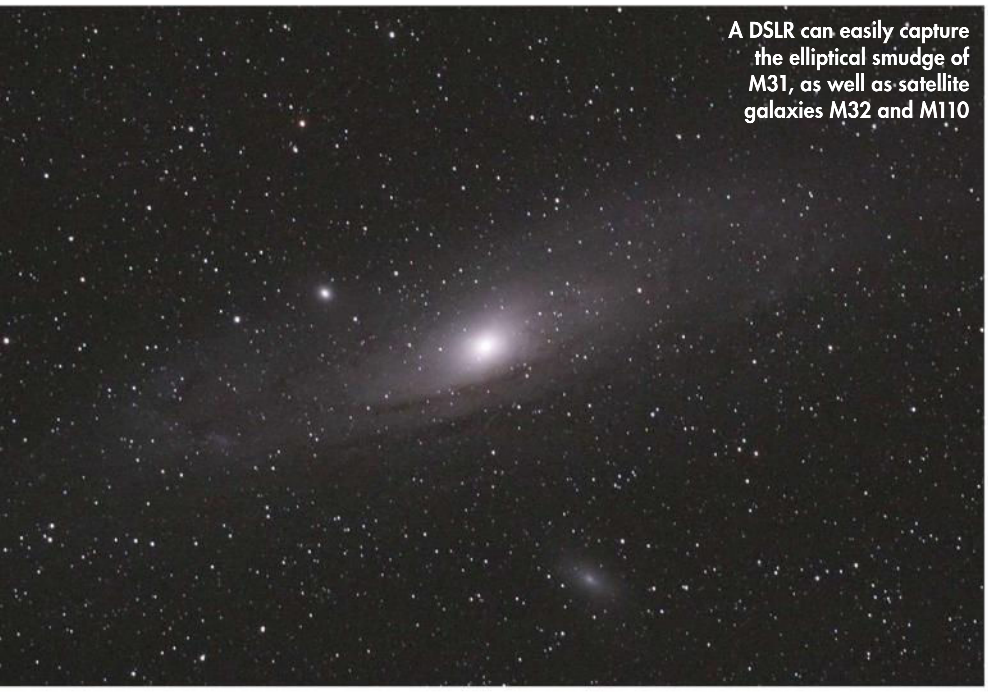
Equipment: SBIG STL-11000M CCD camera, Borg ED101 refractor, Baader LRGB filters.



ASTROPHOTOGRAPHY TUTORIAL

WORDS: PETE LAWRENCE

SHOOT M31 WITH A DSLR



A DSLR can easily capture the elliptical smudge of M31, as well as satellite galaxies M32 and M110

RECOMMENDED EQUIPMENT

DSLR, 300mm (or less) lens, driven mount, shutter release cable or laptop plus control software

The Andromeda Galaxy, designated M31, is said to be the farthest thing you can see with the unaided eye from a normal dark-sky location – mountaintops do not count.

There are a number of ways to locate this far-flung object, the easiest of which is to start from the Great Square of Pegasus. Imagine a line from mag. +2.4 Scheat (Beta (β) Pegasi) in the upper-right corner of the square, to mag. +2.1 Alpheratz (Alpha (α) Andromedae) in the upper-left corner. Extend it for the same distance again, then bend the line up slightly to arrive at mag. +2.1 Mirach (Beta (β) Andromedae). From there, turn by 90°, heading up the sky to reach fainter mag. +3.9 Mu (μ) Andromedae. Just above this is mag. +4.5 Nu (ν) Andromedae. Under darkish skies, M31 can be seen close to this star.

From an urban environment, the galaxy can be quite hard to see due to light pollution, but from a dark site it looks rather tantalising. M31 is notably elongated and smudgy in appearance. It also has a reasonable apparent size. And if it looks that good to the naked eye, surely it must look amazing through binoculars or a telescope.

The sad truth is it doesn't. It looks larger and if you have a sufficiently wide field of view you can also spot its two satellite galaxies, M32 and M110, but M31 itself looks like a larger smudge.

This is to do with the part of the galaxy you're looking at. M31 is a spiral galaxy tilted towards Earth by 13°. This means that we get to see it as an ellipse in the sky. If the galaxy were tilted over by 90°, it would appear face on; we would be able to see a bright circular core surrounded by spiral arms.

So, pick up your camera

The elongated smudge that we see is just the core of the galaxy. The outer spiral arms are there but they are much fainter and so harder to see. A large telescope with an aperture of 12 inches or more will start to show the arms, mainly by virtue of the contrast between the arms and the dark dust lanes between them.

The overall size of M31 in the sky is impressive. The bright core ellipse measures 30 arcminutes by 10 arcminutes; that's an apparent size equal to one full Moon by a third of a full Moon. A typical mid-exposure image of M31 will reveal more of the outer structure. In an average DSLR shot, this increases the galaxy's size to 2° by 0.5°, or four full Moons by one full Moon. The deepest exposures reveal an immense object measuring more than 3° by 1° (six full Moons by two full Moons) in apparent size. Exploring the outer regions of M31 is fascinating, and not too hard to do as long as you have a driven tracking mount onto which you can mount your camera.

In order to catch the majesty of M31, you'll need a field of view that can encompass its full size, or slightly larger, to give it a bit of sky context. For an APS-C DSLR this means a focal length in the order of 300mm or less. For example, on a Canon 60D, a 300mm lens gives a field of view measuring 4.3° by 2.8°, which is about right. As an alternative, you could use a short focal length telescope with a focal reducer.

Whatever arrangement you use, it will need to be attached to a driven mount. If your mount offers autoguiding, then this is even better.

Once you've mounted everything, I'd recommend the use of a programmable remote shutter release cable. If you are able to connect your camera to a laptop, there are several programs that can control exposures that way. One advantage of computer software is that it often provides focus assist functions too.

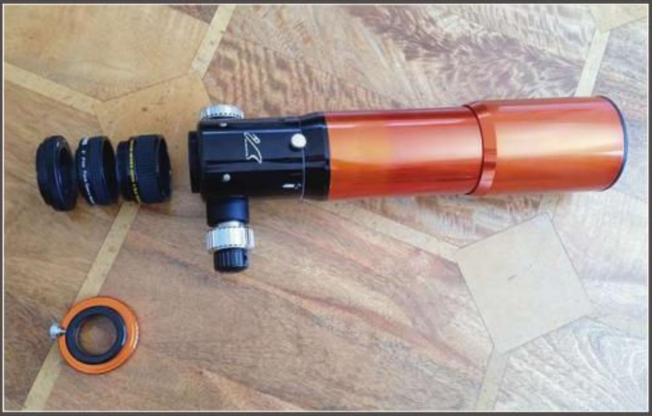
Follow the steps opposite and see if you can bag yourself a photo of several hundred billion stars, all in one shot.

KEY TECHNIQUE

One basic but very important technique for M31 images is removing the effect of unwanted 'stuck' or 'hot' pixels. These will appear like stars in your image, but originate from within your camera. Fortunately, getting rid of them simply entails capping your telescope or lens and taking an exposure of the same length as the main shot. Once this has been done, it's a relatively simply job to remove the false stars with image processing software, ensuring that the ones that are left are the real deal.

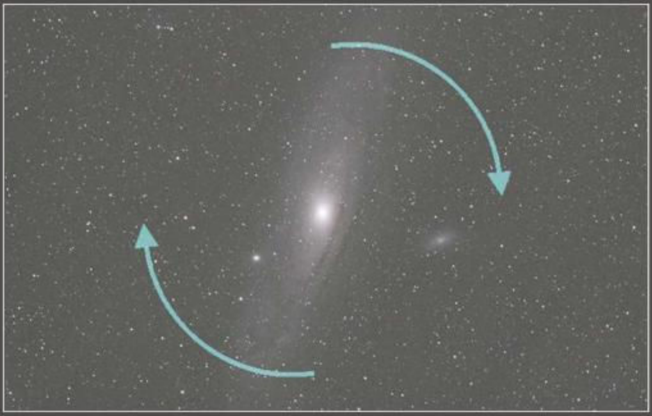
ALL PICTURES: PETE LAWRENCE

STEP BY STEP GUIDE



STEP 1

Decide on the lens you are going to use. It could a standard photographic lens or a short focal length telescope, but it needs to have a focal length of 300mm or less. A focal reducer may be useful to bring a slightly longer focal length scope into the required range. Ask your telescope stockist for advice for your particular setup.



STEP 2

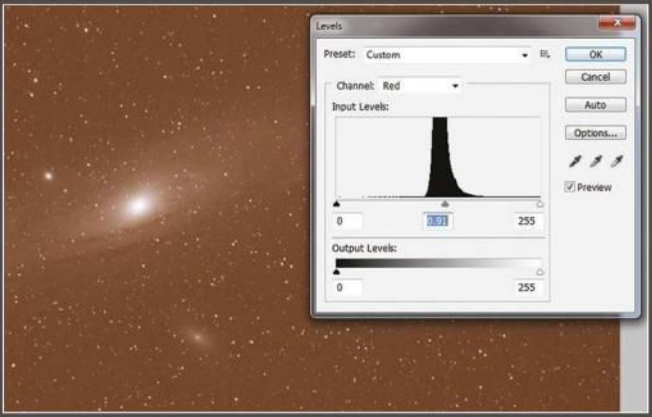
Attach the camera to a driven equatorial mount and set the ISO high. Aim at the galaxy and focus roughly. Take a 20-second shot and check the orientation. Rotate the camera so that M31 comfortably fits in the frame. If your focal length is on the longer side, you may need to fit it in diagonally.

STEP 3

Once you're happy with the orientation, secure everything and focus as accurately as you can, then reduce the ISO. For non-autoguided mounts, try setting the ISO to 800. For autoguided systems, drop it down to 200-400. Lower ISOs will give a better tonal result and reduce digital noise.

STEP 4

The exposure you use depends on many factors, from tracking accuracy to the level of light pollution, so you'll need to experiment. Start at 30 seconds, then step up in 30-second increments. Use the longest exposure that doesn't show trailing. Remember to also take a shot with the lens covered. This will be your dark frame.



Preset: Custom

Channel: Red

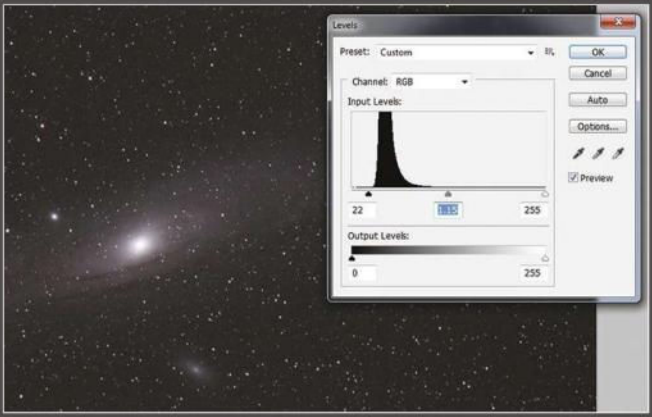
Input Levels: 0 0.91 255

Output Levels: 0 255

☑ Preview

STEP 5

Open your best image in a layer-based editor. Load the dark frame as the top layer, and set its blend mode to 'subtract' or 'difference'. Reduce orange light pollution in Levels by moving the red channel's mid-slider right until the image shows a slight green hue. Drag the green mid-slider the same way, with a final tweak on the blue.



Preset: Custom

Channel: RGB

Input Levels: 22 1.15 255

Output Levels: 0 255

☑ Preview

STEP 6

Close the Levels window to confirm the change and reopen. Adjust the mid-slider's position to find a pleasing brightness for the galaxy. If the background is too bright, drag the black slider so it just touches the histogram. Once you're happy, close Levels. Open the Curves tool, and alter contrast and brightness to suit.

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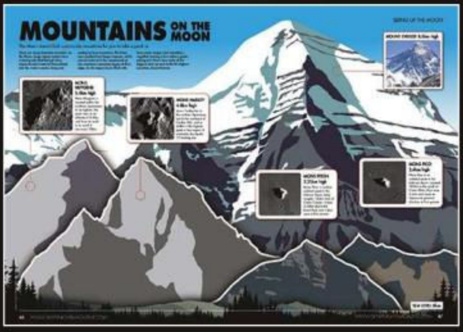

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The Oculus - All-Sky Camera

The Oculus is a recent introduction to the innovative portfolio of Starlight Xpress products. The Oculus uses a SuperHAD CCD from Sony which has all of the wonderful benefits of an interline Sony CCD, such as incredibly low thermal noise and a very fast electronic shutter (no need for mechanical shutters). With the exceedingly low noise electronics and a fast f/1.2, 150 degree fisheye lens, capturing the night sky in exquisite detail is now simplicity itself.

The Oculus is USB powered and driven but does require a 12dc input to drive the built in anti-dew heaters. The software supplied allows you to capture a series of exposures and add them together to create a dramatic avi movie of the night sky.

Active Optics Unit

The Active Optics unit provides excellent Image stabilisation, giving significantly better images. The light passes through the 13mm optical window on to the main imaging camera whilst an off-axis autoguider, such as the Lodestar X2, is used to view the edge of the telescope field via an OAG providing accurate positional feedback to the control software. High speed corrections of the star field position are generated and applied to the Active Optics unit by moving the optical window, refracting the light to the corrected position without any need to move the mount, thus avoiding the delays associated with conventional guiding.

Unlike cameras with an integrated guider chip, the Off Axis Guider puts the guide camera ahead of any filters that the user fits into the recess provided and so guiding sensitivity is always at maximum.

Major Features of the AO-LF

- **Image tracking and stabilisation using a high speed tip-tilt optical window.**
- **Fast tracking speed of 5mS per increment.**
- **Overcomes rapid gear errors to stabilise even difficult mounts.**
- **Compatible with other makes of camera, given suitable control software.**
- **Clear aperture of 60mm for up to 35mm full-frame size chips.**
- **Short optical length - 70mm with OAG, 38mm without.**
- **Low power consumption. Less than 600 mA at 12v DC when moving - 50mA quiescent current.**
- **Compact and lightweight - only 132mm in diameter x 32mm long - less than 700g.**

Spectrograph

The New Spectrograph - Built-in Lodestar X2 autoguider and reference lamp, this compact, highly effective spectrograph brings a whole new dimension to capturing and analysing astronomical light.

Key Features:

- Grating specification: 550 lpmm.
- Resolution: 2000.
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- Useful spectral range: 340 - 900nM.
- Total spectral length: 31mm.
- F ratio for fully illuminated field: F4 and higher.
- Slit specifications: 20uM x 1mm, 50uM x 1mm, 50uM x 2mm, 100um, 300uM & 3mm holes.
- Extra features: Built-in Lodestar X2 guide camera co-axial with spectrograph slit via beam splitter.
- Camera attachment: T2 male thread with fine and coarse focussing. Horizontal slide for selecting spectral range.

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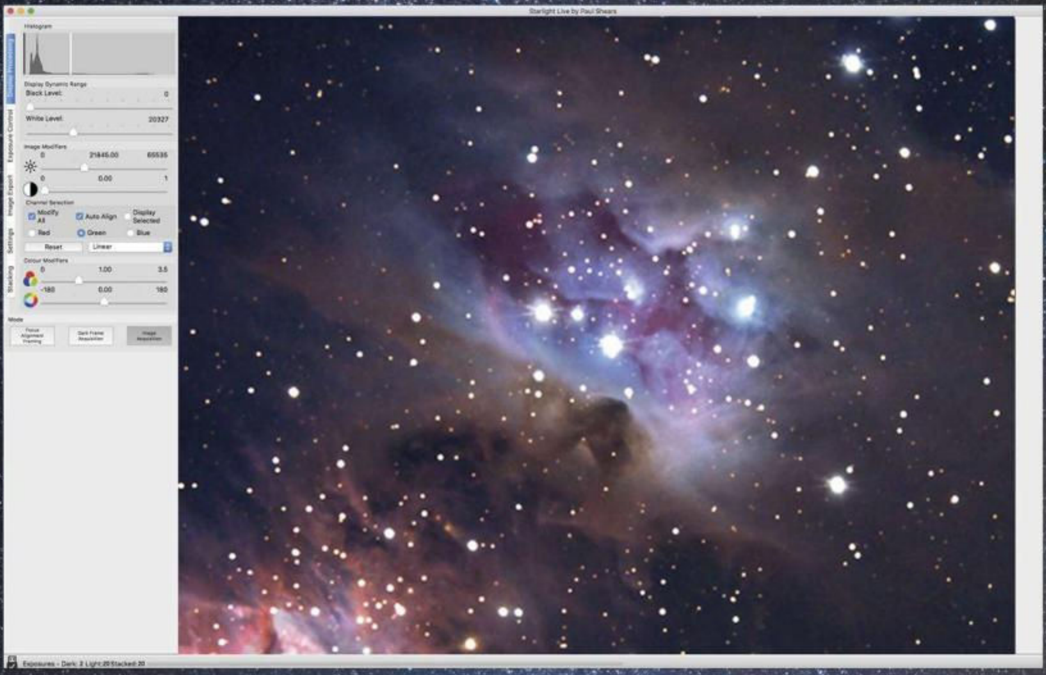

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ULTRASTAR & ULTRASTAR-C

- Sony ICX825 EXview II CCD
- 1.45M Pixels (6.45um x 6.45um),
- 2/3” format CCD, * 16 bit ADC
- QE ≈ 75%, * Passive cooling - very low dark current,
- 5e- read noise, * Full well depth - 23K,
- 2 frames per second, * Weight - only 70g,
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